PB 189 255

GUIDELINES AND CRITERIA FOR COMMUNITY WATER SUPPLIES IN THE DEVELOPING COUNTRIES

Bureau of Water Hygiene
Rockville, Maryland

1969

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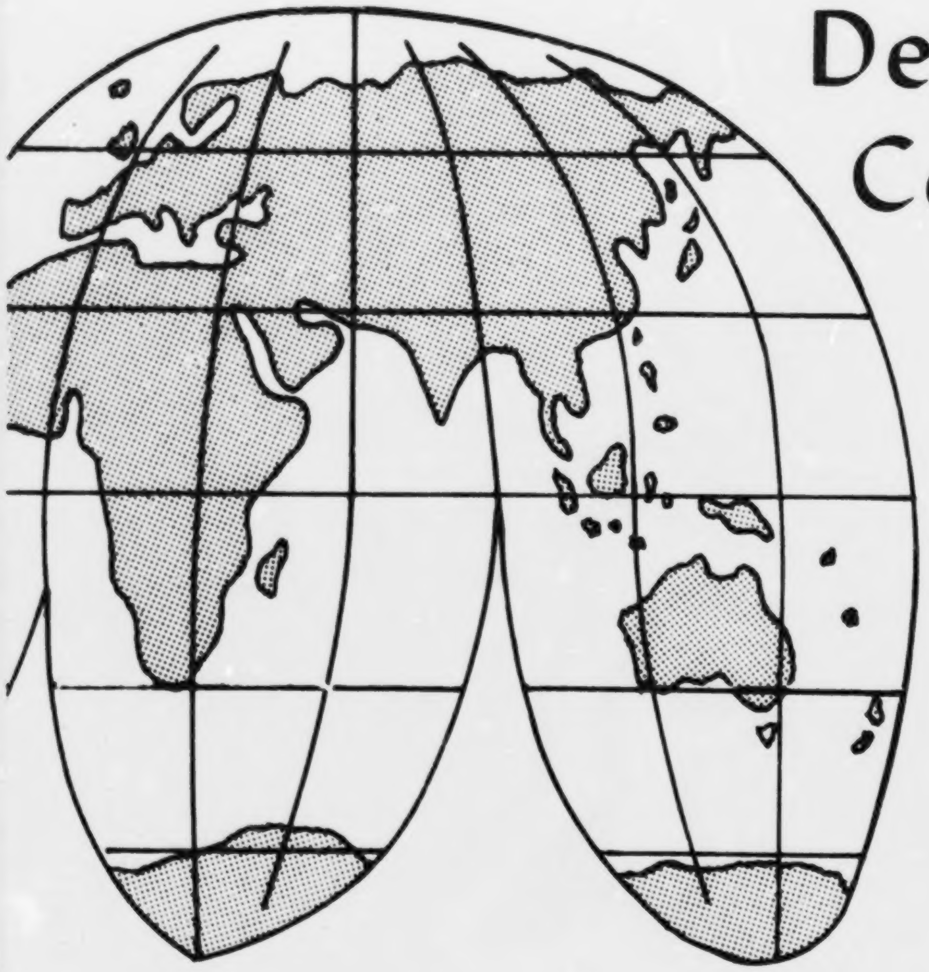

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This report is a synthesis of ideas on guidelines and criteria developed from team surveys of community water supply programs in twelve developing countries, four of them in Asia and eight in Latin America. The purpose was to examine AID operations in this field and identify those factors contributing to the development of successful projects as well as those hindering such development. Chapters are devoted to (a) policies, laws and institutions, (b) program planning, (c) capital financing, (d) manpower and training, (e) technical standards, (f) project development, (g) contracts and construction, (h) operation and maintenance, (l) water utility management and (j) developing public support.

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HEALTH, EDUCATION, AND WELFARE
Public Health Service

Consumer Protection and Environmental Health Service
Environmental Control Administration
Bureau of Water Hygiene
Rockville, Maryland
1969

FOREWORD

This report was developed in accordance with a Participating Agency Service Agreement (PASA) between the Agency for International Development (AID) of the Department of State and the Public Health Service (PHS) of the Department of Health, Education, and Welfare.

It has been generally assumed that the lack of foreign exchange is the major deterrent to the implementation of water supply activities in the developing countries. However, there is ample evidence that this is not the case. George D. Woods, former President of the World Bank, summarized this in an address to the Economic and Social Council of the United Nations on March 26, 1965, in these words:

"Neither general programs nor even generous supplies of capital will accomplish much until the right technology, competent management, and manpower with the proper blend of skills are brought together and focused effectively on well-conceived projects." This statement is unanimously sustained by those in the field of development finance. In other words, until technical and managerial competence is available and organized in the developing countries, productive development projects are limited.

To obtain the essential data and information for this study, the PHS provided teams of consultants to evaluate the community water supply programs of 12 developing countries located in various parts of the world. These consultants were selected on the basis of their broad experience in community water supply programs and projects. The Public Health Service project staff consisted of a project director, a staff engineer, and a secretary. In addition, the Water Supply and Sea Resources Program of the National Center for Urban and Industrial Health, PHS, provided the services of a sanitary engineer on the project for approximately one year. A list of the consultants and the project staff is included under Appendix II.

The 12 countries which were evaluated by the consultant teams were selected on the basis of their location, variations in types and extent of programs, and past and present United States assistance. They were Brazil, Costa Rica, El Salvador, Guatemala, Honduras, Korea, Nicaragua, Pakistan, Panama, Peru, Philippines, and Thailand.

Each of the consultant teams prepared a detailed report on its field studies. These reports and information obtained from the various international agencies which provide assistance to the developing countries in the community water supply sector furnished the basic information used in developing this report. Each team was briefed for several days in Washington, D.C. by the project staff and the international assistance agencies before departure from the United States. These briefings covered a complete rundown on the past, present, and proposed future community water supply programs and projects of the country to be visited. They were extremely helpful in orienting the consultants regarding the individuals to be contacted, local customs, and the prevailing social, cultural, and economic conditions they might find. A list of the briefing agencies and their staffs involved in these briefings is included in Appendix III.

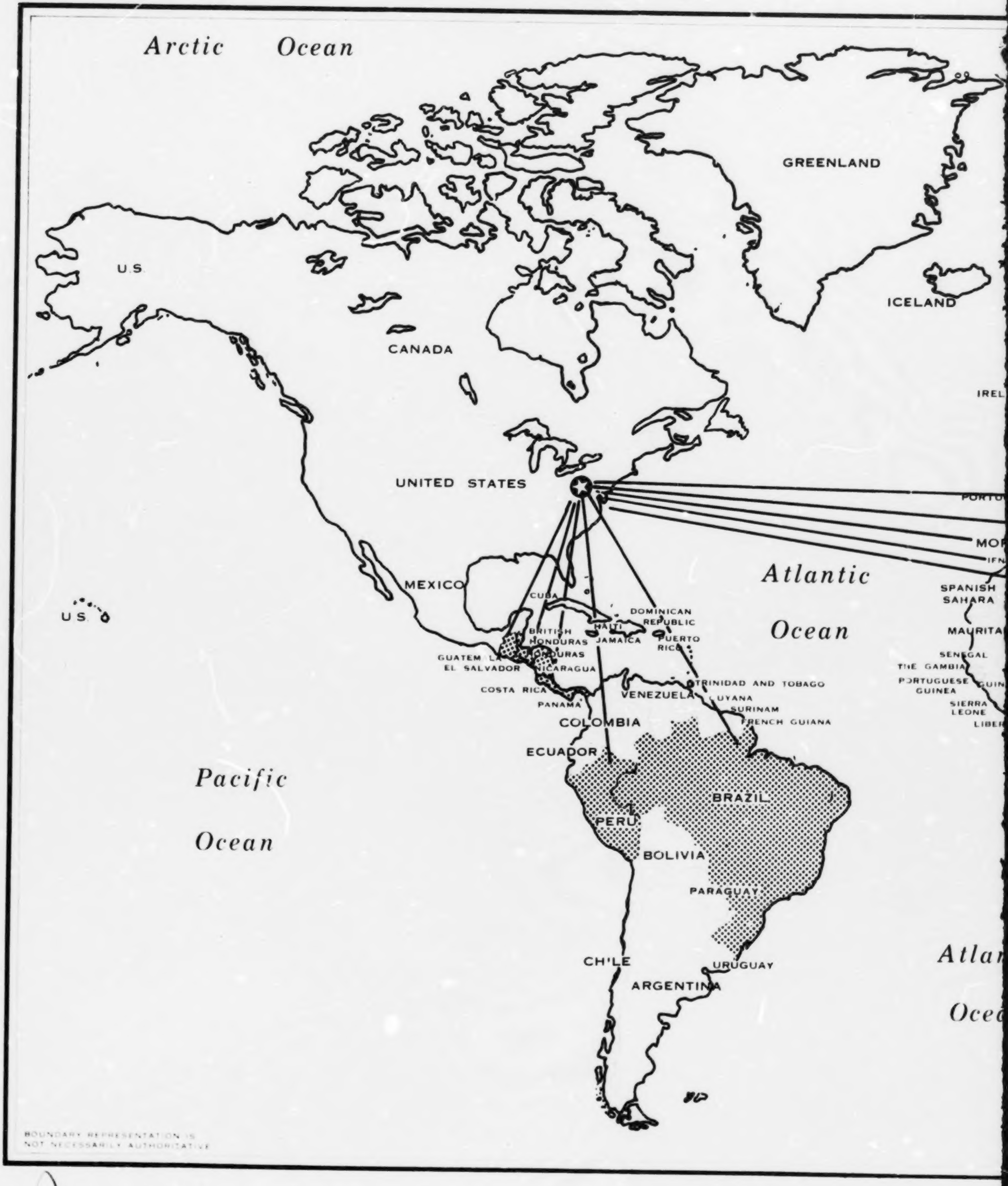
While on the foreign assignment, the consulting teams were under the general direction of the USAID Mission Director and his staff. The country missions were extremely helpful in ensuring the success of the teams' evaluations. Their efforts in arranging for conferences with host government officials, providing transportation for field trips, arranging housing accommodations, and extending other assistance received the unanimous praise of the consultants.

Likewise, the cooperation and assistance the host country officials extended during the conduct of the field studies made it possible for the consultants to obtain a tremendous volume of information and impressions during the limited period allowed for their evaluation (approximately four weeks in each case).

The Public Health Service wishes to acknowledge the assistance which it received from the USAID Country Missions, the World Health Organization, the Pan American Health Organization, the International Bank for Reconstruction and Development, the Inter-American Development Bank, the U. S. Department of Commerce, and many other agencies and individuals for their assistance in making this study possible.

Acknowledgment is also made of the assistance received from the various offices of AID in Washington including the Office of Engineering, the various Bureau Offices, and the Country Desks.

Special acknowledgment is made for the assistance rendered by Mr. Arthur H. Holloway, Chief, Community Water Supply Branch, AID, Washington, whose advice and assistance were constantly available to the project staff. His broad knowledge of existing community water supply conditions throughout the world was of untold value in broadening the scope and depth of this report.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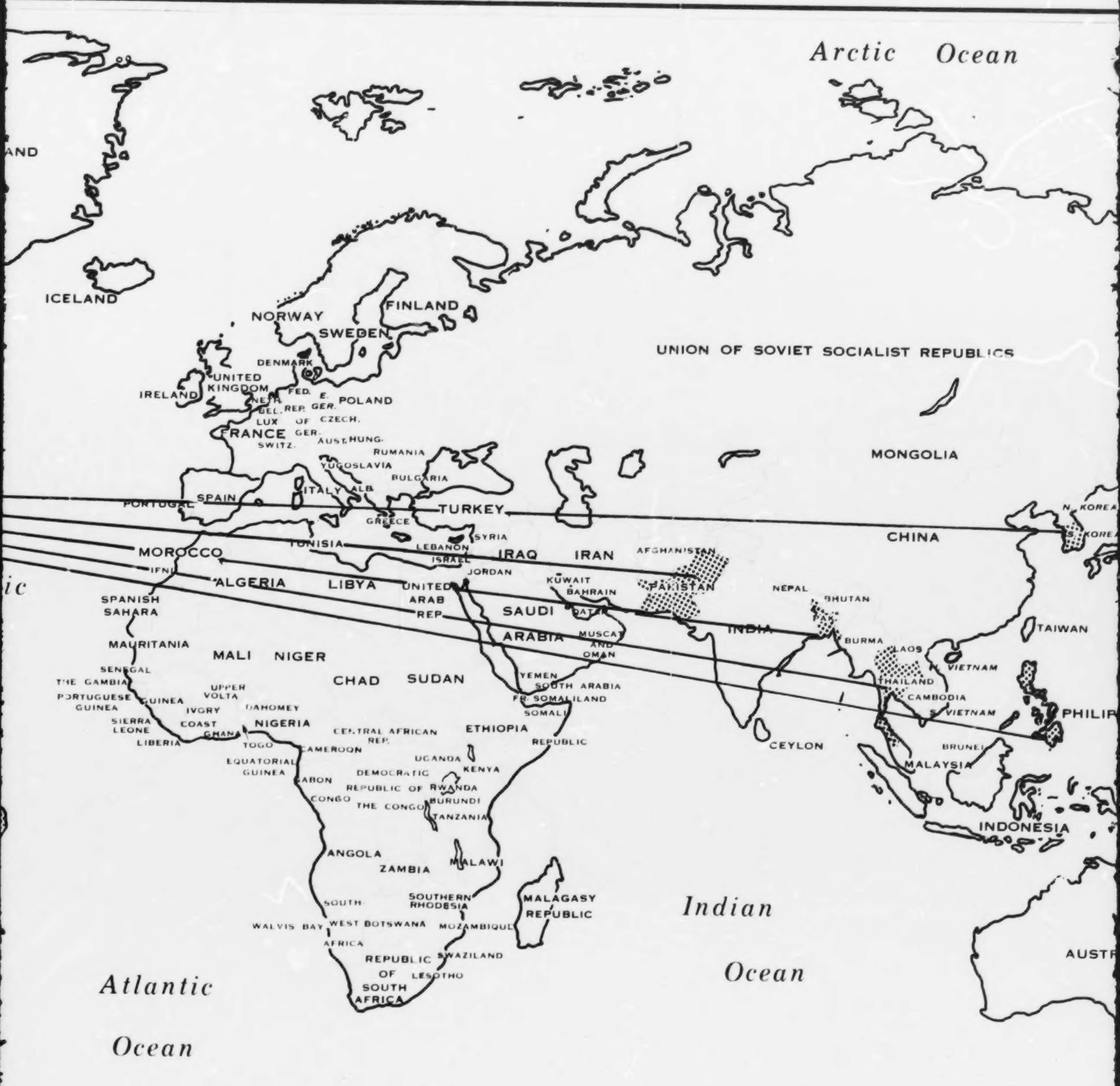
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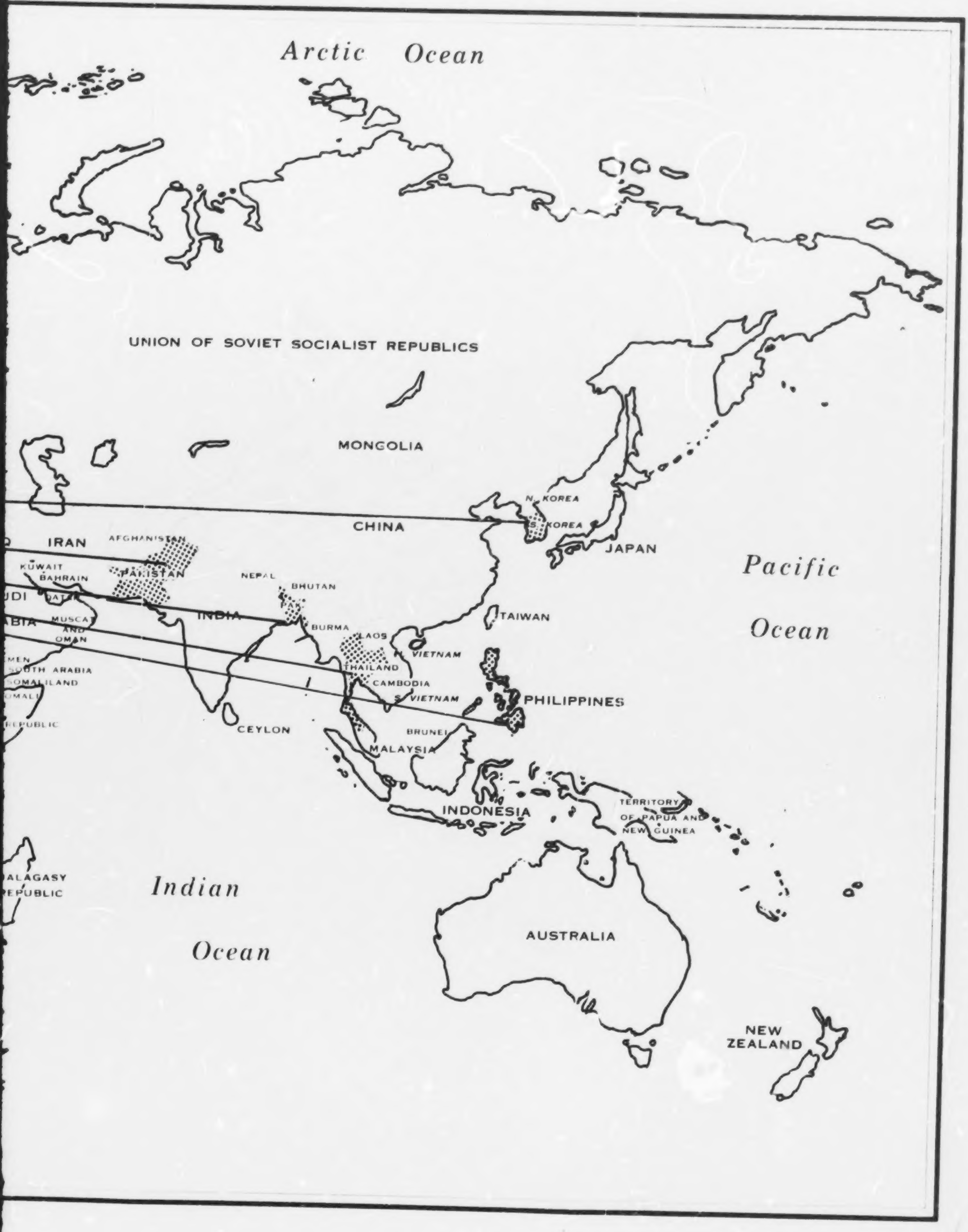
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NEW ZEALAND

The time and effort devoted to the preparation of Chapter XII by Miss Janet K. Anderson, Office of International Health, PHS, is acknowledged with sincere appreciation.

The Public Health Service takes this opportunity to acknowledge with thanks the excellent service rendered by the consultants who made up the expert field teams that assessed the host country programs.

LIST OF AGENCIES

AID	Agency for International Development Department of State
AIDIS	Interamerican Association of Sanitary Engineering
IDB	Inter-American Development Bank
PAHO	Pan American Health Organization
PHS	Public Health Service Department of Health, Education, and Welfare
WHO	World Health Organization

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Chapter I

SUMMARY OF GUIDELINES AND CRITERIA

CONCLUSIONS

A critical evaluation of the community water supply needs of the developing countries of the world can only lead to the conclusion that the problem is monumental and widespread. The developing countries are undergoing a rapid population growth. This is true for the outlying communities and villages as well as the established urban and industrial areas. Consequently, the demand for water is rapidly increasing. Viewed from the perspective of conditions which existed at the beginning of World War II, however, it is encouraging to find that in some of these countries, and even regions, considerable progress has been accomplished. There are many countries and entire regions where little or no progress is apparent

The lack of safe and adequate water supplies for domestic use—i.e., human consumption, personal hygiene, household cleanliness, and public services is a serious public health problem and these, along with inadequate water for industrial processing, retard economic progress in the developing countries. There is widespread reluctance on the part of Ministries of Health to assume responsibility for the health aspects of community water supplies and also to promote and support, in an aggressive manner, the programs needed to resolve these problems. There was considerable evidence to indicate that this situation is not improving and is actually retrograding in some countries.

Most success stories associated with community water supply programs and projects are the result of political and managerial leadership in the individual countries; institutional development in the community water supply field; competent technical personnel; program plans that include realistic objectives and goals; and good training programs. It was noted that countries most advanced in these elements were countries which had received technical assistance over a period of years. The failures are most frequently in the areas of management, and poor operation and maintenance of the completed projects.

It was apparent, in view of the magnitude of the community water supply problem of the developing countries throughout the world that the major portion of the capital funds will have to come from within the individual countries. It is regrettable that efforts to solve the problem of mobilizing indigenous capital resources have been only partially successful. The adoption of sound rate structures by some countries is an important step in the right direction. Another essential step required for attracting local financial resources is a program of information and education to enlist public understanding and support. The availability of international capital for projects that are technically and fiscally sound has not been a problem in the recent past. It was found that those countries that have received long-term technical assistance are now qualifying as major recipients of international capital in the form of loans.

The need for trained manpower in community water supply continues as a critical problem in most of the developing countries. Meeting the manpower requirements calls for a broad spectrum training program. It is impractical and undesirable to expect that training of the magnitude required can be accomplished exclusively outside the developing countries. Training within the individual countries can and must be expanded. These training programs should include academic training for engineers; specially designed training programs in the field of management and administration of water and sewerage utilities; and extensive in-country training programs for foremen, operators, and other skilled workers. The establishment of local training programs will require technical assistance in the planning of these programs and the training of the faculty and staff.

The participant training programs sponsored by AID, WHO, PAHO, and other international assistance agencies and private organizations have been an important factor in the progress which the developing countries have made in their community water supply programs over the last 25 years. This progress is clearly identifiable in Latin America which has received such assistance for the longest period of time and as a result has made the most progress in developing their own programs.

The benefits of training are often lost where personnel policies and programs fail to provide the incentives necessary for recruiting and retaining the best available personnel.

In the past, the agriculturally oriented economies of the developing countries required limited amounts of water for domestic and industrial use in any specific area. With the present trend of urbanization and industrialization, however, the quantities of water required by municipalities are substantial and must receive serious consideration in the allocation of the total water resources. Due to the diverse needs for water it seems apparent that these countries should develop sound national policies and institutions to deal with total water resource planning and allocation. It was found that few of the countries are giving this problem the attention it deserves.

Very few of the developing countries have the basic data for planning national programs or for designing individual projects. Many have not assigned the responsibility for the collection, analysis, and distribution of such data to agencies with adequate staff and facilities. The United Nations and AID have recognized this deficiency and are assisting a number of countries in the development of institutions and the training of personnel to fill this gap.

The foreign exchange requirements and overall cost for many community water supply installations could be significantly reduced by giving due consideration to the availability of locally manufactured materials and equipment. Developing local industry for the production of basic water system materials as an alternate to importation has not received sufficient attention. The promulgation of material and equipment standards would reduce engineers' time now devoted to drafting detailed specifications for individual projects. It would also provide the manufacturers with more detailed information on the requirements of the products needed.

The developing countries are, for the most part, repeating the past mistakes of the industrialized nations by their piecemeal approach to national problems in community water supply development. Enthusiasm for individual capital projects too frequently obscures the more important objective of developing a national program and institutions to provide adequate quantities of safe water to the population and industry. Another common oversight is the failure to provide the personnel and material resources to operate and maintain the completed works. Similarly, there was a noted lack of coordination and a failure to assign responsibility clearly among the various agencies involved.

Most of the international lending agencies are making concerted efforts to assist the developing countries in improving their water supply management capabilities and practices. These efforts are usually related to individual projects for which loans have been made. This is a step toward overcoming a serious problem, but falls far short of meeting the management needs of the national programs.

It was observed that many water supply utilities in the developing countries did not follow sound business practices. A water supply utility is a business enterprise and requires sound business management to maintain fiscal viability. Inadequate management practices lead to poor quality of operation and maintenance which in turn accounts for poor service and quality of water. This is a clear waste of economic resources and is a serious problem throughout the world, especially among the smaller communities.

GUIDELINES AND CRITERIA

The guidelines which follow are necessarily general in character and do not constitute precise measures for dealing with all elements of water supply programs. It is believed that consideration of detailed program plans should take into account all of the guidelines and criteria contained herein. Decision making, however, will always require careful study and consideration of local conditions.

The guidelines are grouped under headings which relate to the specific chapters following in the body of the text.

OBJECTIVES

Community water supply development programs should be planned to provide adequate quantities of safe water to meet all the needs of the population 24 hours a day throughout the year. Current practices in most developing countries are inadequate to satisfy minimum public health requirements. The service should be provided into the homes or as near the dwelling as economic considerations will permit. While water for domestic use is the principal goal, the provision of water to industry is of substantial importance to economic development and will contribute to the fiscal viability of the water utility.

POLICIES, LAWS, AND INSTITUTIONS

It is essential that developing nations establish a national water policy, enact basic water laws, and dutifully administer the enforcement of these laws. Additional legislation is required to establish water pollution control as part of the overall planning of the national water economy.

Community water supply development can best be achieved by national water policies which provide: development of institutions and procedures for financing capital requirements; establishment and financing of functional agencies to collect, interpret, and correlate the basic data required to plan, develop, and administer nation-wide or provincial programs; and implementation of administrative, technical, and managerial training programs necessary to insure competent management, operation, and maintenance of the completed systems.

PROGRAM PLANNING

The development of water resources will be most successful when it is integrated into the general planning for urban, industrial, and regional development. Developing nations require more effective community water supply program planning, in contrast to individual project planning. Plans should be projected over 5 to 10 year periods to insure that financing, materials, and logistic support are available when needed. Strong support in the legislative and executive branches of government is essential in accomplishing long-range program goals.

The development of successful community water supply programs can be materially assisted by providing capable, long-term, technical support to the developing countries through bilateral and multilateral assistance agencies to advise in the planning and implementation of programs.

CAPITAL FINANCING

Additional investigation and study is necessary to resolve the complex problem of capital financing of community water supply programs in the developing countries. Major lending institutions should provide guidance and leadership in such investigations and studies with primary emphasis directed toward determining methods of developing local sources of capital to finance the water supply programs.

Educational programs are needed to create an awareness of the improved health benefits to be derived from safe water supplies, and their contributions to the overall economic development of these countries. This is a means of promoting local community support, the importance of which is generally recognized by most international lending institutions.

Many developing countries lack the foreign exchange or satisfactory credit required to support extensive programs. Increased use of locally produced materials and equipment will alleviate this problem to some extent.

Some countries continue to carry out their development programs by direct project grants by the central government. This discourages the local interest and support required to establish self-supporting operations. In some cases, national fiscal policies require strengthening to insure that comprehensive programs can be continued at an orderly and uninterrupted pace.

It is important that the recent trend among international development agencies toward loans rather than grants for capital investment be continued as a method of establishing community water supplies as self-sustaining, viable entities. To encourage the growth of this trend, loan institutions should keep in mind that water systems are utilities which depreciate more slowly than other utilities, therefore, loan terms and grace periods can be generous.

MANPOWER AND TRAINING

Critical personnel shortages exist in the middle and lower echelons of professional, administrative, and supervisory positions. Manpower development programs are essential to build capable management organizations.

Engineering curricula needs revision, placing additional emphasis on local circumstances and resources in the application of engineering principles to water supply problems. Graduate training of professional and administrative personnel should be provided in the universities of the developing countries when facilities are available. The United States and other industrialized nations could provide faculty assistance and other types of specialized input. Available United States owned local currency should be utilized where available to develop programs of scholarships and fellowships to send students to universities and technical schools in their own country.

Continuing education programs require strengthening and should be designed to meet the specific needs of the countries involved. Local university and technical school facilities can be more effectively utilized to provide short courses and other forms of continuing education.

There is a decided need for on-the-job training of semi-skilled labor, sub-professional supervisory personnel, professional personnel and administrative personnel. Foreign consulting firms can assist in this regard by utilizing local personnel in performing their contractual services.

Improved personnel policies are needed to provide satisfactory salary scales and seniority systems and to eliminate nepotism. The adoption of suitable merit systems is desirable for efficient operation of water supply organizations.

TECHNICAL STANDARDS

Health agencies have an obligation to assume the responsibility of assuring that the population is provided with safe water. This responsibility includes the establishment of standards of water quality and service, the surveillance of water supply operations to insure compliance with the standards, and the promotion of water supply development.

The official health agency should maintain a staff competent to prescribe minimum standards of design, construction, and operation to assure compliance with essential health safeguards. They should also provide assistance in the training of personnel in the public health aspects of water supply.

Most countries need to develop material, equipment, and design standards. This may best be accomplished in each country by appointing a select group of qualified professionals to develop standards and by promoting regional or international cooperation in standards development.

The international assistance agencies should continue and supplement their present policy of providing advice and assistance to the developing countries in the development of technical standards.

PROJECT DEVELOPMENT

Agency responsibility for community water supply activities needs to be clearly defined to avoid duplication, competition, and confusion of functional responsibilities.

There is a need for the responsible agencies to devote more effort to providing guidance in financial analysis programs and the development of design criteria, technical standards, operating manuals, and training programs. These agencies should encourage the strengthening of local consulting engineers' competence for individual project development.

The design of water facilities should be realistic and adequate for the intended service, utilizing as far as possible material and equipment manufactured or available locally, and simplified to better match the limited skills of available operating and maintenance personnel.

The potential use of groundwater resources should be carefully considered in preliminary plans and feasibility studies for community water supplies.

The continued and expanded use of expert consultant assistance by the international assistance agencies is necessary to improve and streamline procedures in the field of project development in the developing countries.

CONTRACTS AND CONSTRUCTION

Experience has shown that the use of turnkey and multi-contract procedures is wasteful and uneconomical and should be discontinued.

Contract payments must be prompt to avoid project delays and to protect the credit ratings of the water supply agencies.

Project design must be compatible with the availability of materials and equipment required for the successful completion of the facility.

Effective inspection procedures and capable inspectors are needed to control the quality of workmanship and materials used in the construction of works and facilities.

OPERATION AND MAINTENANCE

Satisfactory operation and maintenance of community water supplies requires a high caliber of water works management. There is room for substantial improvement in this field.

It is essential that water utility budgets provide adequate funds to employ and retain competent management personnel to direct the administration, operation, and maintenance of the water supply system.

Detailed operation and maintenance schedules are necessary to efficiently utilize available personnel.

Well planned and organized training programs should be conducted for operation and maintenance personnel at regular intervals.

WATER UTILITY MANAGEMENT

All international assistance loans granted for community water supply development should include a provision that the borrowing country provide suitable management training for water agency personnel.

Developing countries should sponsor and give top priority to training for municipal officials and water utility managers in the field of administrative management. Specific instruction is needed at all levels, including academic training, seminars, refresher courses, correspondence courses, and on-the-job training. Assistance should be provided by national water supply agencies to the municipal agencies, through monitoring, surveillance and technical support.

DEVELOPING PUBLIC SUPPORT FOR COMMUNITY WATER SUPPLY PROGRAMS

International lending agencies and water supply advisors should assume a more active role in the development of understanding and support for water supply programs among key government officials, community leaders, influential individuals, and the general population. This is an educational process which is needed at the inception of program planning, during negotiations with country officials and continuing throughout the development of feasibility studies, project agreements, and project implementation.

International agencies should provide professional advisors to assist in planning and conducting educational activities which will facilitate cultural and environmental change, to achieve maximum benefits from community water supplies.

INTRODUCTION

It is a well-known fact that water is necessary to sustain all life—plant and animal. An adequate supply of piped water, together with a knowledge of personal hygiene and household cleanliness, constitutes the most important weapon in the war against the filth-borne diseases so common throughout the underdeveloped[1] nations of the world. Pure water for human consumption will reduce deaths and illness resulting from diseases transmitted through water. Providing pure water solely for drinking purposes, however, will never solve the problem of filth-borne diseases. In the developing countries, a large percentage of the deaths and illnesses from dysentery, typhoid fever, cholera, infectious hepatitis, typhus, trachoma, intestinal parasites, and yaws is caused by a lack of sufficient water on or near the premises to maintain minimum standards of cleanliness.

Inadequate and unsafe water supplies which contribute to human energy loss, high death rates, medical expenses and shortened life expectancy seriously retard the development of agriculture, industry, and the community.

Dr. Abraham Horwitz, Director of the Pan American Health Organization (PAHO), from his own observation and public health experience in the developing countries, recognizes that one of the major factors retarding economic development is the lack of just plain water for purposes of personal hygiene and household cleanliness. He said: "If a single program were chosen which would have the maximum health benefits, which would materially improve the standard of living of people, that program would be water supply with provisions for water running into or adjacent to the house."

The foregoing statement should not be interpreted to minimize the importance of water quality. It is recognized that large-scale epidemics, such as the infectious hepatitis outbreak which occurred in New Delhi, India, in the fall of 1955, in addition to causing illness and suffering, can retard development. On the other hand, the developing countries cannot afford the multiple safety factors that are commonly used in the sophisticated design and treatment of domestic water in the developed nations of the world.

U.S. FOREIGN ASSISTANCE

The Agency for International Development (AID), U.S. Department of State, is responsible for administering United States

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[1] Throughout this report when the words "underdeveloped", "developing" or "less developed" countries are used, "block" countries are excluded.

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foreign assistance to developing countries. The first large-scale U.S. foreign assistance program was initiated by an order of the Council of National Defense, approved on July 30, 1941, which created the Office of the Coordinator of Inter-American Affairs. During the intervening years, the foreign assistance program objectives and methodology have been subjected to periodic evaluation and change.

The work began in 1941 as a program of financial grants and technical assistance to the Latin American countries to develop sources and production of materials essential to the United States in the event of war. The program has evolved over the past 28 years into one of economic assistance to stimulate viable democratic institutions among the friendly developing countries of the world and to improve the living standards of economically depressed peoples.

From its very beginning to the early 1960's, the promotion of modern public health practices was given high priority by the United States policy makers responsible for administering these various foreign aid programs. Control of water-borne enteric diseases through improved water supplies has been an important part of these basic health programs. The objectives were to demonstrate the benefits to be derived from providing an adequate supply of potable water to meet the needs of personal hygiene. Matching money grants were used to construct water systems for smaller communities and to demonstrate modern day engineering practices in construction, operation, and management of such supplies. Training programs were initiated to develop the host country's capability to operate and manage these improved water plant facilities. Participant training fellowships were included to send engineers and technicians to the United States and other countries for postgraduate instruction in the design, operation, and management of community water systems.

During the 28 years that the United States foreign aid program has been in existence the basic program policies have changed considerably. Beginning in 1961-62, the policy shifted to a program which deemphasized health. This was brought about by a change in the broad policy of shifting from social to economic programs supported by loans for capital improvements with the corresponding de-emphasis on social improvements and technical assistance.

REASONS FOR THIS STUDY

This study was prompted by the recognition on the part of AID officials of the need for an impartial evaluation of international community water supply activities by an agency having the necessary technical personnel. The interest in such an evaluation was based upon: (1) the large expenditure of U.S. funds which had gone into the program in the past; (2) the changes in policy that have evolved regarding the type of assistance provided over the past 28 years; (3) the varying degrees of accomplishments; and (4) the need for an evaluation of the impact of community water supply programs on social and economic development.

Presently available estimates on the total U.S. expenditures for community water supply programs and projects abroad is approximately one billion dollars. A large portion of these funds has been in the form of loans. Some of the loans made prior to 1962 may be repaid in local currency and a majority of those made since then will be repaid to the U. S. Treasury in U. S. dollars.

The policy changes instituted in 1962 within AID that are of primary interest to the community water supply field are the following:

(1) A drastic reduction in the direct hire technical personnel partially offset by increased use of contract consultants;

(2) A gradual reduction in grants concomitant with an increased program of low-interest-rate loans;

(3) Emphasis placed on individual projects rather than on national programs.

THE PLACE OF COMMUNITY WATER SUPPLY IN FOREIGN ASSISTANCE PROGRAMS

Once it was established that the United States would embark on a program of economic assistance to friendly developing countries there could be little doubt about the desirability of including water supply activities in such a program. The local populations, and in most instances their governments, give priority to provisions for community water supplies. The problem is very great. The water supply system of almost every city and village needs improvements. Few travellers have escaped the miseries of sickness caused by poor sanitation or contaminated water—in spite of the fact that they were protected by innoculations and well informed on precautions that should be taken for protection against water-borne infection.

The magnitude of the problem can be expressed in another way. According to the census figures published by the U. S. Department of Commerce, the total population of the developing countries, eliminating the block countries, *was 1.5 billion in 1964*. Using a population of 2,000 as the dividing point between urban and rural, the Department of Commerce showed population figures of 350 million urban and 1.15 billion rural. Crude estimates indicate that, of this rural population, a total of about 1 billion people have no access to any public water system. Of the remaining 0.5 billion (urban and rural) it is estimated that 150 million are served by a water connection inside their premises and the remaining 350 million served only by an outside public tap. Although no statistics are available on the quality of the water served by public systems in the developing countries, it is well known that many of the systems are totally unsafe and that others, due to negative pressures in the distribution mains, insufficient treatment, or poor operation and maintenance, are potentially unsafe. Some authorities estimate that 90 percent of the people in the underdeveloped countries lack adequate piped water service or are being supplied with unsafe water.

In the Third Report on the World Health Situation, the many individual health problems identified by governments (85 countries reporting) included environmental deficiencies as their most important health problem. The following is a direct quote from the above report.[2]

> "But reviewing the whole situation, with special reference to the developing countries, the great obstacles in the way of obtaining the optimum level of health remain fundamentally unchanged. They are:
>
> Environmental deficiencies
> Communicable diseases
> Shortages in health services manpower, and the dearth of training facilities
> The inadequacy of available financial resources"

The importance of community water supplies in the total environmental health field has long been recognized and the above information indicates that the governments of the developing countries have placed top priority on this problem.

It is difficult to attach monetary values to the estimated 10 million deaths and the 500 million incapacitating illnesses per year that are attributed to inadequate or unsafe water supplies in the developing countries,[3] but a team of U. S. experts collaborating on the "Water for Peace Program" stated ". . . to attach dollar values to the economic losses, a conservative estimate of five billion dollars ($5,000,000,000) saving per year would justify a heavy economic investment in . . . safe, potable water!"[4]

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[2] World Health Organization, Twenty-First World Health Assembly, Supplement to the Third Report on World Health Situation, Introduction, pp XVII and XVIII, Geneva, May 1968.

[3] Water for Peace, A Report of Background Considerations and Recommendations on the Water for Peace Program, The Inter-Departmental Committee on Water for Peace, p 3, March 1967.

In addition to the health benefits associated with an adequate and safe community water supply, a community can derive many economic benefits. A few of these benefits are indicated as follows:

(1) The ability to attract new industry, which raises the living standards of the individual and increases tax revenues;

(2) The provision of adequate fire protection with the accompanying reduction in fire insurance rates;

(3) Increased property values accompanied by increased tax income;

(4) A decrease in the need for hospital and medical care associated with water-borne diseases;

(5) The long-term benefits derived from promoting municipal responsibility and leadership;

(6) Increased production by a work force free of enteric diseases and improved school attendance and learning ability;

(7) Improved standards of living including personal and household cleanliness and household modernization, and;

(8) An overall improvement in the community through clean streets, irrigated parks and gardens, etc. with their concomitant attraction for additional residents and tourists.

CONTENTS OF THIS REPORT

The material in the following chapters of this report is based on an evaluation of the community water supply programs and projects in 12 developing countries throughout the world and on additional information provided through AID and various other United States and international agencies involved in community water supply activities. With the exception of Brazil, all the field evaluations were conducted by contract teams of experienced sanitary engineers (usually three on a team) selected for their expertise in the field of community water supply. The Brazil evaluation was conducted by three senior engineers of the Public Health Service, Department of Health, Education, and Welfare, who also had broad experience in community water supply. (See Appendix I.)

It must be understood that, because of the wide difference in the economic levels of the developing countries, the varying extent of their water resources, and the limited information available concerning existing water systems, this report could cover only the worldwide community water supply problems in broad general terms. It should be emphasized that the examples, comments, and suggestions contained in the following chapters are guidelines and always should be accompanied by detailed studies and evaluations of the local problems preparatory to final decisions on program and project planning.

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[4] Draft Report, Task Unit A, Community Water Supply and Health Protection, International Conference on Water for Peace, February 1966.

The report attempts to cover the broad phases of community water supply programs. This includes legal authority, planning, financing, and training institutions at the central, state, and local government levels. It also includes the engineering and administrative aspects of individual community water supply projects, such as feasibility studies, plans, specifications, bidding procedures, construction practices, manpower, water quality, materials, water revenues, operation and maintenance, and management. The report emphasizes those problems that the consultants and the authors considered to be the most serious in the developing countries.

Although this report does not cover research and development in the water supply field, it is apparent that this is an area where the developed nations of the world could make a substantial contribution toward solving the problems of the underdeveloped countries to the mutual benefit of all nations. Likewise, it does not cover the rural domestic water supply problem in any depth. Many of the problems discussed, however, apply to rural communities (usually under 5,000) served by a piped water system. Undoubtedly the problem of providing an adequate supply of safe water for the rural population of the developing countries is far greater than the urban problem discussed in this report, both from the standpoint of total number of people affected and the multitude of problems associated with rural water supplies. Although most of the techniques for designing rural water supply facilities are known, there is still a lack of knowledge on how to transfer these techniques into effective rural programs on a national or provincial scale.

The limitations on time and funds for this project did not permit any detailed studies of the community sewerage programs in the developing countries. However, both AID and PHS recognize the need for community sewerage projects. While water supply should receive first priority, the planning for sewerage programs should follow closely thereafter. In fact, it would be logical for the same agency to administer both programs. Most of the legal, institutional, financial, and management problems discussed in this report would apply to community sewerage as well as community water supply.

Chapter III

POLICIES, LAWS AND INSTITUTIONS

WATER RESOURCES

This study was not directed to gathering information on the broad field of water resources. However, community water supply programs are influenced to a great extent by overall water resources development. Therefore, some general consideration of this area is necessary.

A number of developing countries have national agencies that are quite proficient in carrying out programs and projects for single-purpose water development projects, especially irrigation and hydroelectric projects. However, most do not have organizations that can plan effectively and develop long-range multipurpose water resource programs or projects. Furthermore, available basic data is seldom adequate for intelligent long-range water resource planning.

As a first step in sound economic development some efforts should be made at an early date to establish the institutions and train the personnel necessary to collect, record, and evaluate reliable hydrologic, climatic, topographic, and geologic data.

Throughout the developing countries of the world water laws vary considerably in their basic philosophy and authority. The history of these laws usually can be traced to the social, cultural, political, and economic evolutions of the particular country. Many recently developed constitutions, legislative acts, and regulations of the countries in Asia and the Far East reflect the ancient civilizations of the area. For example, Old Chinese, Muslim, and Buddhist laws are intermingled with the more recent concepts of Spanish, French, and British common law. In Latin America, those laws that do exist are partially derived from Spanish, Portuguese, British, and United States laws. In some countries, little or no constitutional authority exists for the control and development of the nation's water resources. Furthermore, very few of the water laws in developing countries are adequate to meet present-day economic conditions.

Either by law or by long-standing custom, the ownership and allocation of water are usually fairly well defined. First priority is the use of water for human consumption; if this is not legally established, it is usually implied.

The United Nations, AID, and other assistance agencies, in recognition of the deficiencies in national policies, basic water laws, and data collection throughout the developing countries of the world, has employed water resource experts to advise and assist these nations in their efforts to improve their water resources programs. Through the promotional efforts of these experts, many countries have created special committees of their own experts to study their water resources policies and recommend changes. In considering the complex problems of multi-purpose water resource development of a total river basin, whether it lies within the boundaries of one country or crosses international boundaries, the need for coordination, both at the national and international level, in the formulation of basic water laws becomes evident. Through international cooperation the individual countries can be assisted in finding answers to the age old questions concerning the ownership of water, the right to use water, the beneficial use of water, the priorities of water use, and water rights administration (riparian rights versus prior appropriation for beneficial use). The advice and assistance of the best local and international experts, including those with expertise in water law, engineering, hydrology, geology, and economics, should be encouraged.

COMMUNITY WATER SUPPLIES

As with basic water laws relating to comprehensive water resources planning and development, the existing legal authority pertaining to community water supply varies considerably by region and by country within a given region. In recent years, a definite trend is toward the legal establishment of autonomous or semi-autonomous water authorities at the national level. The administration of potable water supply programs or projects at the state and local levels by autonomous agencies is noted in fewer countries. (More detailed information on authorities is contained in the following section entitled "The Case for Community Water Supply Institutions.") The legal limitations of all these authorities are usually defined in the enabling legislation and vary from country to country. Some of the federally created agencies have been given total authority and responsibility for administering a national program including broad powers for planning, constructing, operating, maintaining, and managing existing and new water systems. Others are limited types of authority with responsibilities that may include some or all of the following: development of a national policy and plan; supervision of capital expenditures; exercise of national leadership; and provision of technical advice and assistance to the state and municipal agencies. There is at least one country where the local community, by declaration in the federal constitution, has complete authority for the development of all community services including the municipal water system. Another country has under consideration a similar national law aimed at promoting viable enterprises for all community services including water systems.

THE CASE FOR COMMUNITY WATER SUPPLY INSTITUTIONS

In some circumstances, a strong national autonomous water authority is needed to support the workable local water utility. Such an agency should set long-range goals and objectives that will encourage and assist municipal ownership and management as soon as the municipality acquires competent management capabilities. Maximum authority should be filtered down to the lowest governmental level, whenever feasible. Where large metropolitan cities are surrounded by densely settled satellite communities, a single water agency to serve the entire area should be considered. These larger sized utilities would permit greater efficiency and more economical unit operations.

In the larger and more populous countries, it is practically impossible for a central autonomous water authority to administer all functions of a nationwide program efficiently. In these countries, it would be far better for the central government to devote its efforts to determining national policy; providing financial assistance, technical leadership, and regulatory control over water quality; establishing standards; and training provincial and municipal leaders in the community water supply sectors. Training should receive high priority, especially in the areas of management, operation, and maintenance for all levels of personnel.

Information indicates that local community leaders are reluctant to assume responsibility for constructing and operating water supplies on their own where partial and sometimes complete central government subsidy was the pattern in the past. The opinion expressed by many of the top government policy makers in the developing countries is that water should be furnished free or at very little cost. This is contrary to sound fiscal management. It is logical that potable water under adequate pressure 24 hours a day every day of the year is worth money, and the water utility is entitled to collect a reasonable charge for this service. The facts indicate that most of the consumers in the medium-sized and larger cities can and will pay a reasonable charge for quality water service when the utility is properly constructed, operated, and managed. Furthermore, it is a fact that those countries that have adopted a national policy of promoting financially self-sufficient community services are making the most progress in solving their community water supply problems.

Therefore, it is proposed that the developing countries, through their national community water supply institution, adopt a policy of promoting financially self-sufficient local water utilities by reducing as rapidly as possible financial assistance to local projects in the form of grants and by developing organizations competent to promote and administer loans in lieu of grants.

GENERAL TYPES OF INSTITUTIONS

It is extremely difficult to make any generalized statement concerning the institutional organizations responsible for community water supply programs and projects in the developing countries. In many of these countries, it is common practice for the central government to accept more responsibility for community water supply programs than is practiced in the United States and other industrial nations of the world. For example, in many of the developing countries almost complete authority to plan, finance, construct, operate, and maintain most of the potable water systems resides in a central government agency with little or no responsibility vested in the provinces or the local communities. With this type of a national institution, the systems are, for all practical purposes, owned and operated by the central government.

With a few exceptions, the central government agency responsible for potable water supply programs is placed organizationally under a public works type of ministry. Although the actual name of this ministry may be Economic Development, Interior, Municipal Affairs, Public Works, etc., its primary interest is usually in the general field of public works. It is not unusual for this same agency to have responsibility for building highways, bridges, public buildings, and canals, as well as community water supply systems.

Many of the developing countries have a national planning agency usually located within the Ministry of Finance, with responsibility for preparing long-range plans for the country's total economic development. Following the usual budget preparations and hearings by the programs before the planning agency, the Ministry of Finance presents a total annual budget to the national legislature for approval. In addition to the government funds appropriated for the central water agency for normal operating expenses such as salaries, transportation, and administration, the agency frequently receives large sums for grants or loans to municipalities for capital expenditures. Subsidizing capital expenditures for potable water supply improvements with grants from the national treasury is not uncommon, and several countries use a combination of grants and loans to provide an incentive for water supply improvements.

At the other extreme, several countries follow practices similar to those found in the United States, where the local communities or private utilities own, operate, and manage their own water systems and are responsible for financing capital improvements and maintaining the water utilities on a self-sustaining financial basis with little or no assistance from the central or provincial governments.

Between these two extremes, there exist many variations. In some of the developing countries the larger cities and metropolitan areas own and operate their own systems, but the central government maintains complete control over the intermediate and smaller systems. In other countries, the policy of the central government agency is to turn over the water utilities to the local authorities when they have demonstrated their ability to manage them efficiently. Details on programs and financing are covered in later chapters.

One of the principal difficulties encountered by local communities in the developing countries is their inability to provide adequate technical and financial resources. This need could be met by institutions at a national or provincial level providing finance, advice, and assistance.

REGIONAL UNIFORMITY IN CENTRAL AMERICA

Some similarity exists in institutional organizations at the national government level in the countries of Central America and Panama. Several factors account for this similarity including size, climate, physical resources, water problems, and origin and background of inhabitants. Other factors include the common market treaty, adopted by these countries in 1961, which brought their governments close together in trade relationships. Another factor is the activities of the Central American Chapter of the Interamerican Association of Sanitary Engineering (AIDIS) and the Zone II office of the Pan American Health Organization, located in Guatemala City, which have been cooperating in promoting uniform design standards and technical training for these countries. These organizations have given recognition to the Sanitary or Public Health Engineer and the contribution he can make in the community water supply field.

Still another factor is the establishment of a regional school of sanitary engineering at the University of San Carlos in Guatemala City. Both AID and PAHO have provided technical and financial support to this institution, which is providing a common ground for the exchange of ideas, program leadership, and training.

With one exception, the Central American countries have established by statutory authority an autonomous or semi-autonomous central governmental institution which has the primary responsibility for community water supply programs and projects. Overall national policy is determined by a board of directors, which usually consists of five or six members. Appointment of board members varies: in some countries, they are appointed by the president; in others, they automatically become members by virtue of their public office.

The administrative organization for the most part consists of a director, a deputy director, and several division chiefs. The number of divisions varies, but usually consists of the following: (1) planning and design (technical); (2) construction; (3) operation and maintenance and (4) administrative management (finance, personnel, audit, etc).

These central government authorities are given powers over the development, construction, quality control, maintenance, operation, and administration of new and existing potable water supply systems. In nearly all cases, they give priority to the larger metropolitan areas. Responsibility for the development of community water supply projects in the villages and rural areas is frequently left to others. Where no clearly defined legal authority exists this responsibility is assumed by the Sanitary Engineering Divisions of the Ministry of Health.

A UNIQUE INSTITUTIONAL DEVELOPMENT

One developing country evolved a unique organizational plan with the advice and assistance of the local AID Mission. Through appropriations by the central government supplemented by a loan agreement with AID, it created a national revolving loan fund to finance sound self-supporting municipal water systems in the cities.

The outstanding feature of this program is the emphasis it places on obtaining municipal financial and management participation. In other words, this program encourages the municipalities to accept their responsibilities and at the same time helps them develop their own management resources. This program is funded by loans rather than grants and provides initial support to the local government in the areas of planning and management advice and assistance.

To implement this program of local responsibility and management the fund is administered by a separately created superintendency within the structure of the National Housing Bank, a public corporation with its own capital and independent administration chartered by the national government. The operating costs of the superintendency are met from income on project loans. The fund is supported by Inter-American Development Bank loans and national appropriated funds in addition to the AID loan. Procedures have been established to determine the economic feasibility of loans for community water supplies. The National Housing Bank makes loans to municipalities on a matching basis and may also make loans to state water supply authorities that have demonstrated their competence in the community water supply field. In both cases, the National Housing Bank plans to channel the loans through local or state banks. In the overall plans of this organization, it is calculated that in approximately 10 years the income from sub-loans will repay the original borrowed money and the additional income which the superintendency will receive in recovering the national appropriated funds will create a revolving fund sufficient to meet future requests. The enthusiasm and the capability of the top officials indicate they will evolve a satisfactory plan.

Specific criteria for sub-loan eligibility and repayment include:

(1) Establishment of a local autonomous water authority.

(2) Local authority authorized to borrow up to 2/3 of project cost.

(3) Maximum amortization period—20 years.

(4) Grace period before principal payments begin—2 years.

(5) Water rates must be maintained high enough to pay the cost of amortization, operation and maintenance.

(6) Initial disbursement must be made within 60 days following sub-loan contract signing.

The objectives of the program are:

(1) To encourage acceptance of a responsible local role in water supply administration.

(2) Encouragement of private capital for financing future water systems.

(3) Decentralization of loan operation to the state level.

(4) Discontinuance of the federal grant system for water supply construction.

A monetary correction is applied to the loans, as well as repayment, to counter the effects of inflation and reduce the possibility of exhausting funds before completion of construction.

Although the grant program still continues, the present emphasis is on loans and it is hoped that the loan program will serve as a deterrent to continuing grant requests. The loan agency will not accept grants as city contributions and, more important, will not approve projects with critical grant constructed components which might make loan funded portions of the system useless.

SUMMARY AND CONCLUSIONS

The international agencies involved in economic assistance to the developing countries should emphasize loan requirements that would ensure financially self-sufficient national programs as well as local projects. A higher priority on technical assistance would go far toward achieving this.

Although considerable progress has been made by the developing countries in their community water supply and water resource development programs during the last 25 years, these programs are still deficient.

Steps should be taken to:

(1) Establish a national water policy and enact the basic water laws necessary to carry out expanded national programs as envisioned by this policy.

(2) Develop the institutions and methods necessary for financing capital investments suited to the local economic conditions.

(3) Obtain and correlate the basic data required for conducting intelligent community water supply and water resource development programs.

(4) Establish and finance the organizations necessary to plan, develop, and administer these nation-wide programs. In the larger countries this should include plans by the national agency to support and strengthen similar organizations at the provincial level.

(5) Implement the administrative, technical, and managerial training programs necessary to ensure competent management and operation of water systems following their construction.

Chapter IV

PROGRAM PLANNING

The material in this chapter relates to national, regional, or state community water supply program planning. A subsequent chapter (Chapter VIII—Project Development) covers the planning related to individual project development.

Many of the developing countries have established national planning agencies that are responsible for developing overall economic development plans in increments of 3-, 5-, or 10-year periods. The national planning agencies take into consideration all the resources of the country and recommend priorities for program development that they consider the most desirable for improving the economic condition of the country in the shortest period of time. These agencies, which are generally in the Ministry of Finance, cooperate with the other executive branches of the government to make recommendations to the legislative branch concerning authorization for appropriations and needed legislation to implement the proposed programs.

The agency responsible for community water supply activities usually will submit its program plans to the national planning agency through established channels. The degree of program progress within the individual countries frequently is directly related to the support that the community water supply agency receives from the executive and legislative branches of the national government. There were a few instances where this support exceeded the requests contained in the program plans. There were many instances where the community water supply agency was unable to meet its established goals. In some cases, this lack of progress was the result of the agency overestimating available resources in terms of manpower, materials, and available projects. More frequently, this problem could be associated with the lack of basic information and data on which to base good long-range planning.

As stated in a previous chapter, many countries do not have reliable basic information on hydrologic, climatic, geologic, and demographic conditions to make a reasonable judgment on the community water supply problem, needs, and resources available within the countries to satisfy the needs. This deficiency in basic information not only handicaps the community water supply programs but most of the programs associated with economic development within the developing nations, i.e., agriculture, power, transportation, communications, public works, and rural and community development. For example, the lack of basic information on groundwater geology is usually the reason that groundwater as a source of supply frequently is not considered in the project plans.

Another deficiency, which handicaps community water supply program planning at the national, regional, and state levels, is the lack of an inventory of existing community water supply facilities. This problem can be corrected within the agency, but it requires personnel, time, and cooperation from the regional, state, and municipal governments. The larger problem of lack of basic data referred to in the preceding paragraph usually will require the establishment of additional national institutions not under the jurisdiction of the water supply agency.

The attitude of the planning section of the water supply agency to "go it alone" noted in a few of the countries, presents another problem. Autonomous or semi-autonomous water agencies are responsible for all phases of community water supply development from preliminary planning through supervision of construction, operation, maintenance, and management of the completed projects. It is very important that the program planning section coordinate with the other sections of the agency and other government agencies in developing long-range plans.

Some of the water supply authorities have made substantial progress in program planning activities despite the limited resources available. More emphasis should be placed on program planning, however, versus project planning, especially at the national level. The fact that only a few of the developing countries have a well-established, effective regional or state community water supply organization is often responsible for the national agency's devotion of additional effort to individual projects. Establishing and strengthening regional and state agencies should be given consideration in the development of their 5- and 10-year program plans.

PROGRAM PLANNING ELEMENTS

Listed below are a number of elements that may be useful in evaluating the program planning activity of developing countries. A well-developed national program plan should consider, insofar as possible, the following:

(1) Determining the total national problem.

a. Basic data on the water resources (evaluation of hydrologic, meteorologic, geologic, and topographic data).

b. Demographic statistics (population distribution, age distribution, urban and rural distribution, trends, etc.).

c. Health statistics (communicable disease, filth-borne diseases, water-borne diseases, death rates, etc.).

d. Inventories of existing community water supplies (total number, population served, type of treatment, source of supply, extent of service, hours per day, etc.).

e. Manpower available (professional, technical, managerial, skilled, etc.).

f. Materials and equipment (kinds, types, quality, quantity, production potential).

g. Determining the available resources for promoting and conducting public support programs as discussed in Chapter XII.

(2) Establishing the needs (a direct extrapolation from 1) above).

(3) Analyzing the resources available to meet the needs (institutional, financial, manpower, and materials).

(4) Establishing realistic program goals for 1, 5, or 10 years (interrelated with 3 above). Different levels of goals based on general levels of funds, personnel, and other available resources may be proposed.

(5) Developing an organizational plan for the institutions that are to administer the program including support of completed projects.

a. Policy and responsibilities (laws and regulations).

b. Personnel (qualifications, salaries, duties and responsibilities).

c. Administrative procedures (line of command, communications, reports, audits, etc.).

d. Physical facilities.

e. Training (formal courses, short courses, refresher courses, seminars, etc.).

Finally, it should be understood that a program plan is not static, something to be followed without deviation. Long-range program plans for 5, 10, or more years in the future should be living, moving plans updated every 1 or 2 years at the time of the regular budget preparation process.

SUMMARY AND CONCLUSIONS

Information obtained by this study indicates that those countries which have planned program goals for their community water supply programs are making more progress than those which have not developed such goals.

(1) The community water supply agencies of the developing countries should set definite program goals for the next 5 to 10 years and make every effort to obtain the support of the legis-

lature and executive branches of their government for a program which will accomplish these goals.

(2) USAID and other assistance agencies should give priority to providing technical assistance to the developing countries in their efforts to develop *national* community water supply programs.

Chapter V

CAPITAL FINANCING

ECONOMIC CAPABILITY

Many developing countries lack the capital funding and institutions necessary to construct water supply systems at a rate needed to meet the urban population explosion. The experience of more economically developed nations shows that water supply utilities, if properly managed, can be self-supporting. Bonds or loans needed for capital improvements can be amortized from revenues, which also cover the operating and maintenance costs.

The customs, culture and political mores of a particular country have a marked influence on the ability of a water utility to pay its own way. There are still a number of countries where the government provides water service free to its people, and often the "free" water is not sufficient either in quantity or quality to meet the needs of the people. With proper education, public relations, and demonstrated ability to provide potable water, however, people will pay for such service.

Although economic development is of great importance, the social imperatives of providing safe water supplies to the local communities should continue to receive recognition as essential health and economic measures. These measures should not be blindly sidetracked in the interest of an apparently more palatable justification of other projects based only on monetary returns. In considering economic development in the context of existing income distribution and type of development, it is important to avoid the apparent conclusion that the benefits therefrom are universally felt among a population as a whole. Observations have shown that where economic development has been extensive, industry has frequently provided its own water systems and made little or no contribution to the local public system. The use of economic development as a basis for the approval of public water supply systems should be supported by reasonable evidence that the supply actually will encourage such development and, in turn, will receive support therefrom.

COMMUNITY SOURCES OF FUNDS

Although not likely to be major in amount, sources of funds within the community may well be the most important in terms of showing local community good faith, interest, and willingness to pay for water service. Furthermore, substantial local support is now an absolute requisite of most lending organizations, even those at the national or state level.

The needed local support often need not be entirely in money; it may include materials, labor, land, or a combination of these. Direct cash participation may come through either a grant or a loan from the local governmental unit, a commitment of certain local taxes or revenues, or a direct budget appropriation to the project during the years of construction.

In addition to the direct contribution of these public funds, occasionally very effective use is made of frontage or property assessments, connection charges, sale of "water rights," and customer service deposits. These approaches can be successful even *during* the construction years to help the community meet its share of the initial capital requirements for the project.

INTERNAL SOURCES OF FUNDS

Almost without exception, a public money market comparable to that routinely used by United States municipalities for financing all manner of local improvements simply does not exist in the developing countries. The concept or practice of public borrowing by means of a bond issue and planned repayment from revenues or taxes is not available for water supply or any other type of local improvement. Instead, there is a long tradition of making major improvements only when and to the extent that funds are available from the central government—and typically those funds have come as an outright grant without the condition of repayment. These grants have come through various channels and from a variety of original sources, both from the country's own tax and revenue systems and from external assistance programs such as AID. The philosophy of development agencies of all types, however, is currently shifting away from grant activity and, instead, emphasizing loans. In areas plagued with inflation, monetary correction clauses have been incorporated in local loans.

A variety of loan agencies and procedures for capital financing of water supply projects are to be found in the developing countries. These include allocations by the central government, development banks and revolving funds especially for water supply programs. An important consideration in many developing countries is the limitation of foreign exchange. Every effort should be made to make maximum use of local materials in the water supply program. The mobilization of internal financial resources remains a crucial problem and deserves the concerted attention of national and international agencies.

EXTERNAL SOURCES OF FUNDS

External assistance is provided either through bilateral agreements (AID, Export-Import Bank) or from international lending institutions such as the IDB and the International Bank for Reconstruction and Development (World Bank).

Interest and principal repayment on large loans obtained from international institutions vary from area to area and with projects. In one country, for instance, such loans range from 2¾ percent to 5½ percent with repayment periods of 25 to 40 years, sometimes with a 10-year grace period on the principal. One current AID loan to another country is at 2½ percent interest, payment in 40 years, with a 10-year grace period. In that same country, an IDB loan is at 2¾ percent interest, payment in 25 years, and an additional ¾ percent on all unpaid principal balance. These sources may lend up to 70 percent or 80 percent of the cost of the projects.

In many instances, a nominal rate is charged to a country on an international loan, and the national government in turn lends construction funds to a project at rates comparable to local bank loans. This policy returns a profit to the national government to be used in supporting additional development programs. Favorable loan conditions must be extended to project loans if adequate water supplies are to be constructed for a large part of a nation's population within a reasonable period of time.

The World Bank (and to a lesser extent, the other lending institutions as well) has developed a comprehensive questionnaire to be used in connection with an application for a loan for a water supply project. The applicant is constrained to adopt certain procedures and policies intended to help ensure the success of the project and the repayment of the loan. The Bank also uses a sound follow-up inspection of all projects having loans to assure good maintenance, operation, and fiscal planning.

REVOLVING LOAN FUNDS

One of the most promising developments in financing water supplies was recently adopted in one of the South American countries. It is a *national revolving loan fund*. Monies are loaned to a state revolving fund that, in turn, lends to municipalities. The present formula calls for one-fourth of a project's cost to be borne by the municipality and the loan to be split evenly between the national loan fund and the state loan fund, with the latter administering the loan. The following loan conditions provide for some commendable reform measures:

(1) Establishment of an autonomous water department;

(2) Good administration, operation, and maintenance of the water department;

(3) Establishment of adequate water rates to pay for the loan and operating expenses;

(4) Maintenance of value of the loan;

(5) Necessary rate increases, in line with minimum salary adjustments;

(6) Financing of a portion (currently one-fourth) of the project cost by local contributions;

(7) Workability of the project economically and technically; and

(8) Guarantee of the loan by authorizing up to 50 percent of the taxes received by the community to be used for repayment of the loan.

IMPORTANCE OF MANAGEMENT

If any lending institution considers making money available for capital improvement, the basic requirement must be the demonstrated ability to manage the utility in such a manner that payments on the loan will be met and that the total loan will be repaid in the stated time. Anything less would not appear to be a sound investment.

Shipman[4] has briefly summarized many of the problems of working with water supply projects in developing countries from his vantage point with the World Bank. Among these are:

(1) Capital-scarce countries cannot afford to tie up large sums of money for facilities remaining unused for extended periods. Staging of construction based on about a 10-year design period has proved realistic.

(2) In the United States construction funds are available from the sale of revenue and general obligation bonds. These sources are seldom available in the developing countries, in part because investors lack confidence in water systems.

(3) Before the World Bank and the International Development Association approve an application for a water supply project, preliminary engineering, feasibility studies, and cost estimates have to be completed. The developing countries frequently encounter difficulty in preparing these studies.

As there is a close relationship between capital finance decisions and project development this subject is covered in some detail in Chapter VIII under the subheading "Investment Decisions Related to Project Development."

SUMMARY AND CONCLUSIONS

The foregoing information, although factual, does not offer a solution to the problem. Financial conditions vary considerably from country to country. This study disclosed that capital financing is a major unsolved element in community water supply programs throughout the world. No evidence was found of a sound treatment of this problem that could be applied broadly.

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[4] Shipman, Harold R., Water Supply Problems in Developing Countries, Journal American Water Works Association, Vol. 59, pp. 767-772, July 1967.

Capital financing of community water supply programs and projects is of such importance that it warrants additional investigations and studies aimed at developing methods and solving this complicated problem. Any solution or methods derived from such studies would be beneficial to the United States which itself provides subsidies for municipal services through tax exempt municipal bonds.

Major international lending institutions should provide leadership in such investigations and studies.

Chapter VI

MANPOWER AND TRAINING

The emphasis placed upon training over the years by USAID, WHO, PAHO, and others is showing excellent results, although within the countries visited a shortage of trained personnel in all categories still exists in the field of water supply. In general, some well trained personnel were found in key management positions. Likewise, there was an abundant supply of semi-skilled and unskilled laborers. The greatest shortage is in the middle and lower echelons of administrative and technical personnel and skilled labor.

There was considerable evidence that many of the well trained engineers were devoting a great deal more time than necessary to water plant design. For example, several countries had complete designs which were 10 to 15 years old for water systems and construction not started to date. These same countries have many unsolved problems in the areas of water utility management, operation, maintenance, and personnel training where the professional engineer could be making a valuable contribution. Evidently the glamour associated with designing a water facility and the reluctance on the part of the engineers to leave the capital cities are partly responsible for the inefficient use of available talent. However, a lack of management leadership and poor program planning must accept the blame for this inefficient use of personnel.

ACADEMIC TRAINING

In general, training for engineers in the developing countries has a heavy theoretical orientation. There seems to be much less emphasis on laboratory courses and problem solving than in United States curricula. This has serious disadvantages. Students may be well grounded in theory but not its application.

In some developing countries, many professors teach only on a part-time basis. They may be actively engaged as consulting engineers or may work for a government agency in addition to their duties in the engineering college. This practice has both advantages and disadvantages. The advantages include keeping the professors well grounded in current practice and providing a degree of coordination and association among the sanitary engineers in the area. The disadvantages are the probable reduction of the degree of contact and access which students have to their instructors, a limited time for preparation, and less research.

Likewise, the training of engineers and other water works professionals from the developing countries, in the United States or

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in some other industrialized nation, has several disadvantages. For example, when they return to their native countries they tend to develop designs based on foreign conditions and criteria which cannot be justified locally. Conflicts arise between the use of sophisticated analytical techniques designed for complex problem solving and planning and the need for the application of fundamental principles to solve problems in developing countries. All too frequently United States trained engineers find it difficult to become accustomed to salary, local conditions, and professional opportunities in their own communities after spending several years in the United States environment. One solution to this problem is to provide the academic training in local institutions. Expert advice and assistance to the local institutions should be provided from the developed countries to overcome deficiencies numerated above.

In those countries with available United States owned local currency AID should encourage a program of scholarships and fellowships for study in the host country colleges and technical training schools—such stipends to be given to carefully selected personnel who will return to or enter service with a water supply agency upon completion of their training. Stipends to train candidates for government service may be useful as recruitment aid. This assistance should also include input into the upgrading of the local educational institutions.

Sincere efforts are being made to expand and improve the training of certain groups of personnel. Short intensive courses are being offered to numerous localities. Course outlines are being developed that show a rather comprehensive treatment of subjects. These subjects cover a wide gamut of needs including plumbing inspection, basic mathematics, drawing, water department rules and inspector's duties, public relations, water works operation, public health aspects, construction methods, operation and maintenance, etc. An outstanding example of a course outline for Engineering Aides in Brazil is given in Appendix III. It is unfortunate that such training is not more widespread.

ON-THE-JOB TRAINING AND CONTINUING EDUCATION

On-the-job training is probably the most used type of training for water supply personnel in developing countries. While this has its limitations, some programs can be very effective. A particularly good example is given by one country where many small water treatment plants are being constructed. This involves bringing the complete crew of operators of a system under construction to a similar system already in operation in a nearby community. The inexperienced visiting operators work side by side with the experienced local operators until they gain the training necessary for them to perform adequately. Personnel may subsequently be given specialized training in regional short-course schools sponsored by the health ministry.

For engineers at medium and lower levels, on-the-job training is provided when they work as counterpart personnel with the consultants in water supply engineering. Training is also given to overseers, draftsmen, and tracers. Seminars are held and special courses for the engineers are conducted. On the other hand, some countries do not provide counterparts to work with foreign consultants, thereby losing a valuable opportunity for practical training and experience for their own people.

Experience varies widely as to the types of on-the-job training. At one location, for example, a United States consulting engineering firm is furnishing technical and advisory service to assist the Department of Health in its planning, design, award and administration of contracts, supervision of construction, and operation of certain potable water projects. This joint effort is used as a vehicle for further training of host country engineers, technicians, administration and managerial personnel. At the other extreme are situations where no planned training programs are in effect. Personnel are hired and trained by association and requirements of the assignment on a need-to-know basis. While crews can be trained without difficulty for taking care of mechanical equipment, such training programs have not been adequate.

Where conditions are comparable, it might be feasible to establish a program to provide one or two years of on-the-job training with parallel utilities in Western Europe or in the U. S. A. Potential administrators, preferably with basic engineering training, could profitably spend a portion of their training period in each of the utility's departments. Studies should include budgeting, organization, project scheduling, personnel supervision and evaluation, and the relationship between management and the community.

Laboratory personnel should be expected to take formal or on-the-job instruction and by written examination demonstrate their knowledge of laboratory control in plant operations.

Short-course training for personnel from public agencies, local officials, and water utility technical and administrative personnel has been demonstrated successfully and should be considered for wider application. Experience has shown, however, that participation is drastically reduced as the length of off-the-job training time increases. Efforts should be made to design such courses in full recognition of the resistance of public officials and utility managers to release key employees for extensive periods of time.

This requires a full awareness of attitudes and problems associated with training efforts of this type which must be adapted realistically to local conditions. University and technical institute facilities and staffs should be utilized more effectively for continuing education programs, development of standards and design criteria, and research applicable to local conditions. Innovation in the development of such programs should be encouraged to capitalize on the varying circumstances and resources available.

High standards of training can be achieved when trainers are selected for their potential teaching abilities and are themselves given good training. A program of teacher training should include not only refresher material for course content but also teaching methods including judicious preparation and use of audio-visual aids. Methodologies employed in short-course presentations such as at the National Communicable Disease Center, PHS, Atlanta, Georgia, is more effective for such training than the classical didactic lecture.

A few of the developing countries have initiated formal training programs for sub-professional staffs. However, there is an urgent need for initiating and/or expanding this type of training in all of the developing countries. This problem should be approached through numerous channels such as trade schools, short courses at educational institutions, short courses taken to the local areas, and regularly scheduled refresher courses. The water supply agency should develop procedures for preparing the sub-professional staff for these courses through on-the-job training, training during the construction of the facility, etc. The development of various types of licensing programs for sub-professional staff will serve as an incentive for the employee to want to attend training courses. Individual job descriptions and performance evaluations will assist supervisors in recommending personnel for training. Personnel policies which include promotions and pay increases for personnel who successfully complete training courses will stimulate training of all types.

AVAILABILITY OF VARIOUS CATEGORIES OF PERSONNEL

There is a general shortage of trained personnel of all categories in the water supply field. In some cases an adequate number exists for the present, but should expanded programs of water supply, sewerage, and environmental sanitation be instituted, the supply of trained personnel would be wholly inadequate. Some areas indicate a severe shortage of technical aides to fill the gap between the engineers and skilled labor.

In the sanitary engineering field many areas report adequate staffing in top management but a lack of middle management or supervisory personnel forces top management people to become too involved in details. Young engineering graduates frequently seek employment outside their native country because of low salaries and lack of professional recognition. In some cases there is a healthy and growing community of consulting engineering firms; in others, there is reported to be too much "government" engineering to encourage establishment of an opportunity for local consultants. General civil engineering skills are more widely available than specialized training in sanitary engineering.

There is a need for recognition of sanitary engineering as an area of specialized training (a sanitary option in the engineering curriculum). Eventually, graduate training in sanitary engineering needs to be initiated where it does not now exist.

In some countries there is an abundance of trained accountants and bookkeepers, but in others a severe shortage. One country is reported to have practically no qualified accountants employed in the water supply field. As with engineers, the shortage of administrative personnel is most acute in the middle and lower levels. The lack of persons well trained in public administration is widely recognized. One suggestion to remedy this shortage would be to encourage engineers taking graduate training abroad to take advanced work in public administration.

Technical people in government service are not everywhere paid on a scale commensurate with industry; hence, where this obtains, they are easily persuaded by industry to take jobs paying higher salaries.

Available manpower resources in the water supply field should be closely examined, including: engineers, sub-professionals such as engineering aides, draftsmen, surveyors, plant operators, etc.; and specialists in other disciplines like hydrology, hydraulics, meteorology, geology, commerce, business, public administration, economics, water resources management and planning, and water quality management and control. The results of this examination will provide planners a valuable tool for overcoming any deficiency noted.

SALARIES AND PERSONNEL POLICIES

One of the items consistently found in all the countries studied was the relatively low pay scale for government workers. Another item almost as universally found was the inadequate spread between lower grade employees and officers and officials of the ministries.

The obvious solution is to persuade the lawmakers of a government, whether it be federal, state, or local, to pay salaries adequate to attract and retain qualified personnel on a merit system.

One South American country circumvents this problem by establishing "mixed" companies to carry out specified missions that usually are performed by governments. By this means it can establish a salary schedule in line with the prevailing practice for the area. Other personnel practices may be established more in keeping with those of industry than those typical of government.

It must be noted that there are some areas where, despite generally low salaries, there is no noticeable tendency for employees to leave government service. Reasons given for this include the desire for security and the prestige and status that accompany government employment. However, the fringe benefits, such as housing, transportation, etc., probably influence their decisions to remain in government service.

Effective management is often hampered by political intervention in the appointment of personnel and in technical and administrative aspects of improvement programs.

One of the serious problems affecting the retention of capable personnel by water agencies is the practice of promotion through the seniority system. This stifles individual initiative and certainly encourages the more ambitious employees to seek other employment at home or abroad. An effective personnel merit system is, therefore, very important in achieving a successful operating program. Under it, every employee should be assured that he holds his post on the basis of his performance and that the evaluation of his performance is made inside, and not outside, the employing agency. Each position requiring more than simple manual skill should be identified by its own position qualification and job description in sufficient detail to indicate the nature of the task to be performed and the degree of supervision to be given. In the area of decision making, the responsibility of supervisors should be stated clearly and respected. Candidates for posts requiring a high degree of personal responsibility should be kept on a probationary employment basis for sufficient time to verify their ability to bear those responsibilities. Promotional and incentive policies need to be adopted after careful planning.

Realistic personnel policies must be established at all levels so that trained personnel will stay on the job and the mission of the program can be realized.

ENGINEERING LICENSES, PROFESSIONAL AND OTHER ORGANIZATIONS

Some countries have adopted the practice of licensing their professional engineers. Not all recognize sanitary engineering as a distinct category. In one case, water supply and water quality control, and sewerage and sewage treatment are two of the subdivisions of the construction category. Another country only recently has enacted a law providing for the licensing of engineers, which law is now in the process of implementation. It remains to be seen what the various categories will be.

A number of countries also have active professional engineering associations. The exchange of ideas and stimulation of thought provided through these go far toward improving utilization of technical knowledge, the enhancement of the status and dignity of the engineering profession, and a better acquaintance among members of the groups. Similar advantages accrue to members of sub-professional associations having objectives of a similar nature.

Promoting the licensing of engineers and the adoption and growth of professional and sub-professional organizations are worthy objectives of any program aimed at improving water supply and waste disposal.

At the stage of development of a number of countries, it is well to advocate the use of university laboratory testing facilities. A side benefit to this practice is that students are likely to become interested in the activity and benefit from the practical application in which they could participate. A program of this kind could serve also as a possible recruitment device for the water works industry and the public health engineering agencies.

In several countries the national community water supply agency issues newsletters and technical publications which help to promote interest among their professional personnel. In other countries the national engineering organizations issue a monthly or bi-monthly publication which keep the profession informed on current issues, projects and opportunities.

USAID has reproduced a large number of technical reports, text books and other publications of interest to water supply personnel throughout the developing countries of the world. Many of these have been translated into the language of the country and placed in public libraries and educational institutions.

SUMMARY AND CONCLUSIONS

Many of the developing countries, with the advice and assistance of AID and other international government agencies have devoted considerable effort to training their community water supply personnel, especially in the professional and technical field. Well planned training programs are also beginning to mature in a number of countries. However, due to program expansion serious manpower shortages now exist.

(1) Manpower development activities should be directed toward meeting the principal shortages in the middle and lower echelons of professional and administrative supervisory personnel.

(2) Academic training of engineers should be revised to include more emphasis on the application of engineering principles to water supply problems within the context of local socio-economic conditions, institutions, resources, and technical development.

(3) Increased attention should be given to the apparent advantages of encouraging the graduate training of professional and administrative personnel in the universities of developing countries, with enrichment from the U. S. and other industrialized nations through faculty and other types of input, rather than encouraging training abroad. A few very select individuals should continue to receive graduate training in the U. S. and other countries.

(4) In those countries with available U. S. owned currency steps should be taken to develop a program of scholarships and fellowships for host country universities and technical schools.

(5) Successful examples of on-the-job training, short courses, and other forms of continuing education should be publicized widely to capitalize on the experiences involved.

(6) Foreign consulting firms should be required to work with local personnel in the interest of training as well as encouraging the growth and competence of local consultants.

(7) Continuing education programs should be strengthened; they should be designed specifically to meet the needs of the countries involved, and local university and technical school facilities should be used more extensively for this purpose.

(8) The adverse effects of current salary scales, the seniority system, and lack of merit systems on water supply development should be examined thoroughly in the interest of an accurate assessment of the manpower problem and possible remedial steps toward improved personnel policies.

Chapter VII

TECHNICAL STANDARDS

WATER QUALITY STANDARDS

The teams of consultants reported that a number of countries have adopted drinking water quality standards within recent years, but that few countries are now enforcing those standards. Drinking water standards of the Public Health Service and The World Health Organization (WHO) are very similar. Both serve as a guide but are not closely followed by those countries that have established their own standards. Some have adopted one or the other in toto. One country is reported to use the *Standard Methods for the Examination of Water and Sewage* for testing and its own standards, based on WHO's, for evaluating those tests.

The bacteriological and chemical quality of community water supplies in the developing countries usually fail to meet the international standards recommended by WHO.* Inadequate treatment, poor operation of treatment plants, negative pressures in the distribution systems, and cross-connections are major contributors to large outbreaks of waterborne diseases. The standards of water service which provide for continuous water under pressure at the customer's tap twenty-four hours a day every day of the year is extremely important in maintaining water quality standards. Constant water service may also eliminate the use of some other source of poor quality.

Responsibility for enforcement of drinking water quality standards is usually placed in the ministry of health. Unfortunately, this responsibility frequently is not carried out. Too often, the water producer is left to check the quality of his own system. The consumer will benefit when water quality enforcement is performed by an agency other than the water utility administration.

Having adopted drinking water quality standards, the ministries of health need to establish regional laboratories capable of chemical, microbiological, and physical testing for water quality. This is essential for proper enforcement of the standards.

Instances were observed in which management showed a lack of knowledge with respect to the public health aspects of water supplies. The ministries of health should promote the dissemination of ideas and practices along this line to improve municipal management and to impress management concerning its responsibility in this area.

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* It is recognized that existing water quality standards are not complete nor are they all based on scientific facts. There is an obvious need for intensive scientific study of water-borne substances and organisms which pose a potential threat to health.

MATERIALS AND EQUIPMENT STANDARDS

Many of the developing countries face serious problems in attempting to develop materials standards. In addition to the lack of sufficient number of institutions capable of testing and setting standards on materials, there is the problem of having to import many of the materials used in constructing community water supply projects.

This problem can be reduced by promoting local production, and several countries are well on the road in this direction. Many of the smaller countries, however, will never be able to solve the problem by this method alone. The small countries in Central America are making some progress through the recently established (1961) common market agreement. A number of the developing countries need advice and assistance in solving the problem of quality control in the manufacture of plastic pipe.

In spite of the foregoing background, there is a definite need for the developing countries to adopt materials standards. Several countries are making considerable progress in this regard. Others have resorted to adopting the standards of some other country or a combination of several foreign standards.

There is a definte need for the formation of an international organization to study and recommend international materials standards for community water supplies similar to those that the American Water Works Association has developed for the United States water works industry. Benefits to the developing countries in reduced inventories, more efficient maintenance crews, and other economies would be tremendous.

If it were possible for all nations to adopt the same set of standards, that would be ideal. Construction cannot be postponed, however, in the hope that an international standard will be adopted. The demands for adequate, safe water supplies for domestic, industrial, and agricultural purposes are too great to permit any postponement of construction. Water supply construction must move ahead with utmost speed.

Generally within each country there are qualified individuals with the in-depth knowledge of national water supply requirements necessary for adopting a given set of construction standards. Every effort should be made to establish a region-wide selection of the particular set of standards to be adopted. A conference among such individuals who also have the authority to adopt such standards within their respective countries might be held.

Depending upon the region, coordinating assistance could well be sought from such nonpartisan agencies as WHO and PAHO. These international organizations and AID are familiar with the problem of quality of materials used in the manufacture of plastic pipe. This is an area where many of the developing countries need advice and assistance.

Standards of pipe thickness, strength of fittings, and the like are based partly on experience and judgment in the application of safety factors providing 2, 2½, or 3 times the actual strength requirements. Although longer life and lower maintenance are usually the result of higher factors, this becomes increasingly important as labor costs become higher. Lower safety factors with resulting lower capital investment may be appropriate for the developing countries where labor costs are low.

Where domestic water meters are used, the turbine type is most common because of its relatively low cost. In one country, at least, a recently adopted standard limits future installations to the oscillating piston type. The reasons for abandoning the turbine meters are interesting. First, the accuracy is poor at very low flows, which is too often the case at very low pressures. More important, however, is the fact that the oscillating piston type meter will not pass more than a trickle of water if it becomes clogged or stuck. Thus, the customer is sure to call for service, and the utility at least has the opportunity to restore the meter to operating condition or to replace it, thus maintaining not only service but accurate billing for water service as well.

Studies have shown that in certain small and medium-sized cities only a small percentage of the single-family dwelling units exceeds the minimum monthly quantity. For economic reasons meters are not recommended under these circumstances. Here there is some merit to the concept that low consumption households could be charged a minimum flat rate while all others could be charged based on quantity actually used.

DESIGN STANDARDS

As would be expected, design standards fluctuate greatly among the developing countries. Several of the countries have developed their own design standards, and others have adopted design standards similar to those used in the developed countries. When the latter method is used, the country frequently ends up with a set of standards that are impractical from the standpoint of local economy and needs. Such standards either cannot be enforced or, if enforced, retard program progress. The range of design standards most frequently used in the developing countries is listed in Appendix V.

The practice of over capacity design to offset high distribution losses could be avoided with adequate leak detection and maintenance programs.

Occasionally, irrational designs have been observed such as multiple risers and discharge pipes from elevated storage tanks, unbalanced distribution systems, and lack of storage and standby equipment, auxiliary power sources, and flexibility. Safety features also need to be incorporated in all designs.

SUMMARY AND CONCLUSIONS

Although the developing countries have made considerable progress in developing technical standards, much remains to be accomplished. The smaller developing countries face a serious problem in regard to material and equipment standards.

(1) The Ministries of Health should assume the responsibilities for water quality by establishing standards and by launching an aggressive program of water quality surveillance;

(2) Each country should establish a committee composed of the best qualified people available to develop standards for materials, equipment, and design based on the needs of the country;

(3) The committee referred to in (2) above should promote a regional or international organization to translate their local technical standards into either regional or international standards, or both, as applicable;

(4) The international assistance agencies should continue and supplement their present policy of providing technical advice and assistance to the developing countries in this area of technical standards.

PROJECT DEVELOPMENT

In most of the developing countries the responsibility for planning water supply projects is either concentrated at the national level or falls almost completely on the local community government. Unfortunately, where the responsibility is placed at the national level, several separate agencies may be involved in the planning and development of a single project. It is the exception when the state (provincial) government or a regional agency has this responsibility or shares it with the local governing body.

PRELIMINARY ENGINEERING REPORT

The responsibility for the preparation of preliminary engineering reports varies considerably among the developing countries of the world. In some countries, this responsibility rests with the local community, while in a few countries it resides in a national or state agency which develops the reports with its own staff. In some cases, the preliminary reports are prepared by consulting engineers under contracts negotiated between the community and the engineering firms. The latter are frequently used by the larger cities and metropolitan areas.

In the briefest terms, the preliminary report usually will describe the present situation in some detail, including the administrative, physical, and technical aspects of the water works. Past and present demands for water, demand variations, customer data, and similar information will be presented as a basis for projecting future needs for water. A proposed project, or often alternative projects, then will be outlined in some detail along with a clear exposition of its merits, liabilities, and place in the long-range planning for the community or area to be served. All too frequently the preliminary reports were found to be based on too much theory and not on a practical evaluation of existing information and data.

Finally, estimated project costs are presented in the degree of detail and exactness considered justified by the requirements of the situation.

In the preliminary engineering report, the engineer presents the technical aspects of the problem and uses his best professional judgment to set forth a solution or solutions. It should verify that alternative solutions have been considered. Often this report will be written and presented in a nontechnical manner for easy understanding by laymen and by top policy and planning personnel who have little or no patience with technical descriptions.

When the preliminary report is completed, the engineer should take no further action until he has discussed his proposal with the agency having approval authority for the project. This procedure will enable the engineer to explain the studies he has conducted and to justify his decisions. It also permits the approving authority the opportunity to explain any differences it may have concerning the engineer's decisions and provides for a free exchange of information that may be helpful to both parties. This practice, which is used extensively in the United States, frequently will save the engineer considerable time and effort in developing the final plans and specifications.

A special word of caution on selection of source is necessary. The most common and often extremely costly error in the entire project development process centers on the failure to search out and fully evaluate all possible water supply sources; all too often ground water resources are overlooked.

Ground water potential frequently is discounted or underestimated because of a lack of basic data, because of faulty or misleading data, or simply because of hearsay. Until careful drilling tests and valid pumping tests have been made, it is unsafe to conclude that ground water in useful quantities is or is not present. Wherever such data are lacking, steps should be taken to provide the missing data. Such steps normally require test drilling operations carefully controlled by a responsible ground water engineer or geologist experienced in well drilling and aquifer evaluation. The determination of aquifer constants (transmissibility and storage coefficients) is always advisable since they provide a sound basis for the evaluation of present and future behavior of wells and aquifers.

FINANCIAL FEASIBILITY

In some of the countries surveyed, the preliminary engineering reports included detailed financial feasibility information. Because many did not, this separate section is included primarily to emphasize the importance of this aspect of project development.

A feasibility evaluation normally builds upon rather than retraces the technical ground covered in a competent preliminary engineering report. The feasibility report may reexamine the need for the project in terms of growth projections.

The financial feasibility report should include these general areas:

(1) Project costs—breakdown in terms of elements, origin, and time sequence;

(2) Sources of capital—origin, terms, and scheduling;

(3) Previous financial experience—water rates, collections, and surplus or deficit;

(4) Projected financial results—detailed evaluation of proposed water rates and all other revenue sources; current expenses, debt services, and all other obligations usually culminating in cash flow projection for at least the next 10 years, or present worth analysis.

Each potential lending organization normally has a preferred form for submission of the feasibility report. Normally, information on proposed organization, management, and operation of the project is desired. The lending organizations emphasize that preliminary engineering and feasibility reports be submitted for review and appraisal before work begins on detailed plans and specifications.

The need for a comprenhensive economic analysis is self-evident. Adequate procedures or methodology, however, for expressing these benefits in economic terms are not available. Engineering firms use a variety of techniques in order to present an economic analysis. The results are seldom consistent and admittedly inadequate.

In substance, the feasibility report should answer these basic questions: Is the project sound? Will it meet the need and meet it at reasonable cost? Is the project suitable for a loan from technical, economic, and management standpoints, or if not, can it be made suitable? Does the utility management or authority have the legal power to establish and collect, and is it willing to do so? Are the customers able to pay for the water used and are they willing to do so?

DESIGN PLANS AND SPECIFICATIONS

The capability for producing plans and specifications was not found to be a serious problem in a majority of the developing countries, although the quality varied all the way from excellent to poor.

The most common criticism registered by competent water works officials in the developing countries was that many of the plants were overdesigned. This complaint did not refer to overdesign from the standpoint of plant capacity, but usually related to the use of sophisticated equipment of foreign manufacture. This type of overdesign should be avoided for numerous reasons. First, the foreign exchange resources of most developing countries is limited and, therefore, the importation of expensive equipment should be avoided whenever possible. Second, the care, operation, and repair of such equipment creates a serious problem from the standpoint of continuous water service. Frequently, many months are required to obtain replacement parts. Third, such importation tends to retard the development of locally manufactured products that could fill the need. Fourth, it requires training local operators to understand and operate such equipment. Numerous instances could be cited where expensive water treatment processes that were not needed have been installed and are not being operated.

In addition to the overdesign of the type mentioned above, there is the problem of underdesign: not underdesign for present needs, but failure to provide for future expansion of the system in the planning process. This includes not only failure to provide for orderly enlargement of the treatment plant, but failure to provide for the future capacity requirement of (future growth) major conduits and distribution lines. The problem becomes serious to the design engineer, especially with the rapid municipal growth due to increased population and the migration of rural populations into urban areas.

Another major challenge to the design engineer is that of simplifying his design, not only from the standpoint of the very substantial capital and operating savings that can result; but to better match the limited operating and maintenance talents available in many of the developing countries. It is important to keep in mind that labor, although it may be relatively unskilled, is abundantly available in most of these countries, and it may be much more economical in the long run to incorporate in the design such treatment methods as slow sand filters and hand-cleaned sedimentation basins. Also, the climate is apt to be warm or even tropical, which not only affects treatment efficiency, but suggests obvious and important savings in the need for housing and protection of many facilities.

Many suggestions for simplification and, in fact, specific design details are described in an article by Dr. H. G. Baity.[5] In speaking of our established western standards of water works design, Baity acknowledges that ". . . in the eyes of designing engineers and public health officials these standards have become sacred. There is no quicker way to raise their hackles than to suggest modification of them." But he concludes: "It has been proven in the doing that under the pressure of necessity the costs of water supply and treatment works, by careful design, and by cutting corners on convenience, aesthetics, civic pride, and luxury, can be reduced to approximately one-half those required under normal western criteria of design."

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[5] Baity, H. G., Community Water Supply in the Developing Countries—Departures from Normal Design Standards. Publication No. 122, School of Public Health, University of North Carolina, Chapel Hill, N.C. (1966)

In this way, Baity argues, the limited funds available can be used *"to give water to as many of the people as possible rather than to give a perfect supply to a few."*

With regard to specifications, they were frequently found to be more detailed than warranted under the circumstances. For example, it is rather difficulty to justify long, detailed specifications for a project that is designed and constructed with force account labor by a national water authority that purchases all of its own material and equipment. Where to draw the line on specifications is one of the problems that the engineers face in countries that have not established sufficient standards for materials or equipment. The problem is complicated further by a lack of authority or procedures to enforce any existing standards. As a result, design engineers have a tendency to draft unnecessarily detailed plans and specifications.

The developing countries should evaluate their engineering resources and determine the best utilization of their talents. They should also determine those needs that can be filled best from within the country and those that cannot be filled within the country. Consulting engineering firms that have capabilities for doing design work on the small and medium-sized cities are beginning to appear in the developing countries. Many of them lack experience for large metropolitan projects and should have an opportunity to work with experienced United States consultants before undertaking these large jobs unassisted. In the smaller nations, a majority of the engineers capable of doing design work are employed by official government agencies. One of the more progressive developing countries prequalifies its consulting engineers and regulates the size of jobs these consultants can accept, depending on their official rating.

REVIEW AND APPROVAL OF PLANS AND SPECIFICATIONS

It is difficult to know how far to go in review and approval of plans and specifications for water supply projects. Experience in the United States and in other industrial nations supports the need for some agency to be vested with review and approval authority.

In addition to the decision as to the proper agency, there is the added problem as to the extent of the authority. A clear cut policy is needed to assign responsibility and authority to an appropriate single agency, if feasible, for final approval of the engineering plans and specifications. Definitely, the policy should be developed to meet the particular problems of the individual country.

In the developing nations such authority may be in the ministry of health, in the national water authority, in the ministry of public works (or construction), or in the national planning agency. In the latter case, the matters are generally referred to one of the other agencies that has a qualified technical staff. Most evidence indicates that provincial and local governments of these countries have little opportunity to participate in these determinations.

A factor that should be reviewed concerns the sufficiency of provisions in the plans for the protection of health. Too frequently it was found that the ministry of health lacked the staff competent to make such a review promptly.

Review and approvals must be prompt. It might be desirable for the policy to provide that if review and approval were not made and given within a certain time limit, the applicant would be notified in writing explaining the reasons for the delay. It was found that delays frequently were caused by unnecessarily detailed review; the requirement of too many signatures, often by persons without qualifications; and lack of communications.

The policy should include in the consideration of the delegation of authority the competence of the local engineers and monetary size and complexity of the project. There is a strong tendency in many of the developing countries to refrain from delegating authority even to well-qualified people. All too frequently insecurity or a lack of knowledge by a superior may be the reason. Other reasons include prestige, political pressure, personality conflicts, and mistrust. In any event, delays in project approval can be reduced by the reviewing agency and the consulting engineer getting together and discussing the project at the time the preliminary planning is completed.

PROJECT SCHEDULING

Project scheduling is closely related to project planning. Where there is a national water agency that does its own planning, design, and construction, the planning and scheduling are the responsibility of the same agency. Even when the construction contract is awarded to private contractors, the national water agency should have a keen interest in the project schedule either directly or through the consulting engineer. Construction delays are a common problem in most of the developing countries. Frequently, projects fall one to two years behind their planned completion dates. Bureaucratic red tape in processing purchase orders and delays in placing orders or in delivering materials or equipment are frequent occurrences. Lack of knowledge or foresight concerning weather conditions, labor, and transportation facilities also cause numerous delays. Delays in clearing critical foreign purchases through local customs cause construction delay. Other causes include such things as not having acquired the right-of-way before the project is started, piecemeal financing, lack of knowledge concerning availability of foreign exchange, and arbitrary reassignment of key personnel. It is impossible to estimate the total financial loss to the developing countries due to such delays, but it is substantial.

INVESTMENT DECISIONS RELATED TO PROJECT DEVELOPMENT

This subject could have been included in Chapter V, CAPITAL FINANCE. However, since it is so closely related to the technical and engineering aspects of individual projects, it seemed more appropriate to include it here.

There are three important aspects of investment decisions in the water supply field:

(1) Definition of the need,

(2) An exhaustive exploration and comparison of alternative ways of meeting the need, and

(3) Calculation of the financial and economic consequences of the investment.

There is a paradox in thinking about water supply investments. On one hand, it is universally considered to be desirable, if not imperative, to have an adequate piped supply of pure water in urban areas. On the other hand, planners hard pressed to find capital for a variety of projects, most of them more glamourous than water, usually decide in the end that water projects can be postponed without much apparent damage to the economy. This paradox arises from the evident, but frequently unspoken fact, that demand for water can be defined in many ways. At one end of the scale, there is the need for two quarts per capita per day to sustain life; at the other, is the desire by an affluent society for water to wash cars, irrigate lawns, and air condition movie theaters. The first step in an investment decision is to establish a point on this scale to represent the objectives of the investment. In other words, how much of the theoretical demand is it reasonable to supply, given the physical and economic facts of the situation. *It is at this point that investment decisions in developing countries frequently begin to go wrong.* Standards of consumpion familiar to consultants from more developed countries are sometimes applied without consideration of wide differences in social and cultural factors, not to mention the difference in ability to pay. Reliable consumption statistics are rarely available to provide a check on such assumptions. It is extremely difficult to establish demand where there are unmetered and illegal connections, huge losses in the distribution system, and lack of production records. These conditions, however, are common in developing countries.

When faced with this problem, it is not satisfactory to simply apply a rule of thumb target and go ahead. The answer is to make a strenuous effort to gather from all sources whatever consumption data are available and to supplement this with spot checks with temporary meters, house to house surveys, and canvassing of large consumers, i.e., industry, hotels, hospitals, universities. Time and money spent at this stage to sharpen demand estimates can be the most productive part of the investment.

Once the demand has been established as well as possible, it is useful even at this early stage to begin to establish a financial frame of reference for the project. One crude, but often revealing, way to do this is to think in terms of a typical domestic connection —say a skilled laborer with a family of six and average per capita consumption of water. Suppose he will spend 2 percent of family income for water. Divide the monthly payment by the estimated consumption and take the result as the overall average rate per unit of water to be sold by the organization. Multiply this rate by total projected consumption and one has an idea of the total revenues which will be available to meet the operating and capital costs of the organization. In a typical system, about 60 percent of these revenues will be needed for operating costs, including depreciation. The remaining 40 percent can be applied to interest payments, normal extensions and renewals, increases in working capital, and all other cash needs of the organization. (This assumes that depreciation covers amortization of debt, which may or may not be the case.) If the financial objective is to earn an 8 percent rate of return on net fixed assets, the 40 percent represents this return. Therefore, $0.40 \div 0.08 = 5$, and one can think in terms of a total investment, including any existing facilities plus the proposed project, of about five times the total estimated annual revenues. This is admittedly a very rough calculation, since all of the elements are subject to fairly wide variation, depending on the local situation. It does, however, give some clue about a realistic size of the project, particularly when a new system is being built.

The next step is to find the best way to meet the estimated demand, keeping in mind the restraints on the size of the project. At this point, engineers, including consultants, frequently begin to think in terms of big, visible, modern, complex, and costly works. This is understandable, but not excusable in areas desperately short of capital. What is needed is a thorough investigation of *all* possible sources, means of conveyance, methods of treatment, and distribution system layouts, using discounting techniques so that alternatives having different investment and operating cost patterns can be compared fairly. It is also necessary to use imagination in choosing materials, methods, and specifications in order to produce a "lean" project that will do the job at least cost. This may involve lowering quality standards used as a matter of course in developed countries, but which are not necessarily vital to the functioning and safety of the system.

When the best alternative has been selected and cost estimates made, it is necessary to consider more precisely the financial and economic consequences of the proposed investment. This may, and frequently should, send the engineers back to the drawing board to look again for a cheaper alternative. To obtain a detailed understanding of the financial aspects of the proposed project, it is necessary to construct proforma income statements, cash flow statements, and balance sheets. The many assumptions used should be considered carefully and written down so that the responsible officials can make a judgment about the validity of the statements. Operations of the existing systems, if any, will need to be included in these statements. The completed statements can then be analyzed by conventional financial analysis techniques.

It will be necessary to arrive at an average rate per unit of water sold in order to make up the income statements. It is necessary to consider the rate structure which would produce this average. The guiding principle should be to insure that there are no gross differences between the cost of service and rate charged for each class of consumer. It is also revealing to turn again to the typical domestic consumer to see what impact the proposed domestic rate would have on his expenditure pattern. Generally, speaking, if the rate exceeds 4 percent to 6 percent of the average family income, the project will need more cost trimming.

A feeling for the economic consequences of the investment can be gained by calculating the internal rate of return (the discount rate which equalizes the present worth of the future streams of cash income and outflow *which can be attributed to the investment itself*) on the proposed project, as contrasted to the financial rate of return for the whole organization. If it is a new system, total revenues and cash outflow would be considered, but the two kinds of rate of return should be calculated nevertheless since they represent different concepts of return on the investment. If the internal rate of return is significantly lower than the returns available from other kinds of investments, it may be desirable to reconsider the scope of the project, the rate structure, and other related factors.

When this kind of calculation is made and it results in a price which seems high, the usual response is to think of ways to subsidize the operation. It should be noted that subsidies do not change the cost to the economy, but simply transfer the cost from one group to another. The important thing to remember is that, once an investment has been made, its economic and financial consequences are largely fixed. The only question left at that time is who pays the bill. Good management can keep costs at a minimum, but there is a limit to what good management can do. Furthermore, the capital already invested in the project is no longer available for alternative investments no matter how attractive. It is for these reasons that time and money spent on preliminary study of the optimum scope of the project are extremely important to the ultimate success of a viable project.

SUMMARY AND CONCLUSIONS

Many of the developing countries have organizations with good capabilities for project development. In fact, it is not uncommon to find several national agencies involved in the same project. Very few of these countries have regional or state agencies with adequate capabilities in this field. Better balance is needed between the economic feasibility criteria and the design criteria of the project.

(1) The responsibilities for community water supply activities should be clearly defined to avoid duplication, competition, and confusion of functional responsibilities;

(2) The assigned agency ((1) above) should devote more of its efforts to providing financial analyses program leadership, and to developing design criteria, technical standards, operating manuals, and training programs, at the same time encouraging the development of the consulting engineers' competence for individual project development;

(3) The sanitary and consulting engineers should give due consideration to the use of possible ground water sources in their preliminary plans and feasibility studies;

(4) The international agencies should continue and expand their policy of providing expert consultant services to these countries leading to improved and streamlined procedures in the field of project development.

Chapter IX

CONTRACTS AND CONSTRUCTION

BIDDING AND CONTRACT AWARD PROCEDURES

The procedures for construction of projects fall into five main categories: turnkey projects, contract projects by competitive bid methods, multicontract projects, materials supplied by owner and construction and installation by a single contractor, and force account.

In a turnkey project, a single contract is awarded by the owner to an engineering-construction firm to design and build the entire project. Aside from legal considerations, this method would be considered somewhat unethical in the United States, at least for public works, but it has been quite common in developing countries. The difficulties in obtaining a quality product with such an arrangement are quite obvious. Turnkey projects are not supported by AID funds or by World Bank and IDB loans.

Contract projects, in which the contractor furnishes all materials and equipment and performs all construction and installation work necessary to complete the project, in accordance with the plans and specifications, and with engineering supervision of construction provided by the water supply agency or by a consulting firm, are used but not nearly as universally as in the United States. At times the prime contractor awards subcontracts, but the prime contractor remains responsible.

The multicontract system involves the awarding of several small contracts for various facets of a project to as many different contractors. This system has two major drawbacks: it is exceedingly difficult to complete the whole project; and political influence on some of the small contracts is easy to achieve. However, it is used quite extensively in a few countries.

A widely used procedure in developing countries is for the owner (national or local water supply agency) to purchase all the major materials and equipment under separate supply contracts and furnish them to the project contractor for construction and installation. Some countries feel that this provides better control over the quality of materials used on a project. Actually, in those countries where the allocation of materials such as cement and pipe, as well as imported material and equipment, is controlled by the central government, this procedure is a necessity.

Force account procedures are also used in developing countries. These procedures involve the government's complete design and construction of a project. The government hires its own personnel, meets its own payroll, purchases its own materials, and provides its own equipment. These procedures are most frequently used in the construction of the smaller plants and for distribution systems, especially extensions and improvements to existing water systems. In some countries having a national autonomous agency, however, force account procedures are used on construction projects of all sizes.

Procedures used for awarding contract projects are similar to those used in the United States. Projects are advertised, bids are opened, the successful bid is determined, and the contract is awarded.

Advertising periods used for projects seem to vary all the way from 7 to 120 days, with the average being perhaps 15 to 30 days. The longer periods are used for very large projects open to international bidding. Some countries require contractors to be prequalified; in such cases, the contractors may also be graded by size and allowed to undertake only a certain volume of work, depending on their grade. Also, in many countries, bid bonds ranging from 1 percent to 10 percent of the amount of the bid price are now required.

Awards are generally made to the lowest responsible bidder, however, there are exceptions. An unusual procedure used in one country is to reject all bids more than 10 percent over the engineer's estimate, take the average of the remaining bids plus the estimate, reject any bids that are less than 95 percent of this average, and then award the contract to the low bidder in the remaining group. This procedure can only result in higher construction costs and seems to be uncalled for, especially when the likelihood of responsible bidding has been increased already by requiring all bidders to be registered contractors.

Generally, performance bonds are being required on contracts in amounts ranging from 2 percent to 50 percent of the contract amount. A 50 percent performance bond is difficult to justify.

Contract procedures in many countries now provide for penalty clauses for failure to complete the contract within the specified time. Enforcement of such provisions, however, is not always carried out.

Procedures for contract payments may provide either for periodic progress payments, as is normally done in the United States, or for payment only upon completion of the work. Frequently, 5 percent or 10 percent of the contract amount is withheld as a guarantee of satisfactory workmanship. This percentage may be withheld until the project is "satisfactorily completed" or for a specified length of time, up to 2 years afterwards.

AVAILABILITY OF MATERIALS

The availability of materials for constructing and expanding community water supply systems varies widely from country to country. As a general rule, basic construction materials such as concrete aggregate, cement, lumber, and brick are quite readily available. In many countries, however, even cement is hard to obtain and is rationed by the national government. Reinforcing and structural steel may or may not create a problem. Many of the larger developing nations are now manufacturing their own pumps, motors, pipes, valves, and meters in sufficient quantities to meet present day demands, whereas a majority of the smaller nations need to import these necessities. Electrical equipment and controls are still in short supply and must be imported by a majority of the developing countries.

The materials procurement problem has many complicating facets. The expanding program of developing local industries capable of producing certain items is commendable. Advantages that may be cited are the use of local materials, employment of local labor, saving in foreign exchange, and sometimes the possibility of finding an export market that will result in greater volume and in foreign exchange earnings.

On the other hand, there may be certain disadvantages. Even after start-up strains and costs are behind the new enterprise, the quality of the product may be mediocre for a long time and its efficiency well below that of the competitive imported item. Thus, the true cost of the locally manufactured item is usually higher.

Another factor that must be considered is the limited types and capabilities usually found in locally manufactured equipment of relatively recent origin. Pumps, for example, because of limited selection, may be more expensive in the long run than imported ones with respect both to capital and operating costs.

Thus a decision on beginning local production of a water works item should lean heavily on hard economic evaluations. The more sophisticated the item, the more certain it seems that continued importation will be preferable. The engineer, however, probably would be doing a still greater service by limiting sophisticated equipment and controls in the design stage.

CONSTRUCTION

Construction procedures and methods used in the developing countries vary considerably from those normally followed in the United States. The most obvious difference is the extensive use of common labor in place of the heavy mechanical equipment used for construction purposes in the developed countries. Effective inspection procedures and capable inspectors to control the quality of workmanship and materials used in the construction of major works and facilities are lacking.

In the developing countries it is not uncommon for construction to continue on a round-the-clock basis under very poor lighting conditions during the night shifts. Several of these countries have private rental firms which will rent heavy construction equipment to contracting firms. However, due to high rental rates and the abundance of cheap common labor, contractors only use such equipment on special types of construction. In at least one country the national government has purchased and imported a considerable amount of heavy construction machinery which the government rents or leases to private contractors at reasonable rates.

Obviously, the time interval for completing a specific construction project is longer in these countries than in the developed nations. The quality of construction at those few water plants visited by the consultants was usually quite satisfactory.

AVAILABILITY OF CONTRACTORS AND LABOR

Most of the developing countries have an adequate supply of contractors capable of handling small and medium-sized projects, and in several countries, contractors have the capability to handle large metropolitan water supply projects. In the larger countries the inability to obtain large construction equipment, either locally made or imported, may be the deciding factor in determining the size of job a contractor can handle. The practice of constructing projects with force account labor tends to retard the growth of competent contractors. As mentioned in the previous chapter, one of the deficiencies in the construction field is the inability to meet construction schedules. In some cases this is due to the inability of the contractor to develop a sound, well-planned working schedule. Just as frequently, it is caused by delays in the delivery of equipment and materials.

Probably the worst problem facing contractors in developing countries is the delay in payments as promised, whether they be progress payments or payments on satisfactory completion of the contract. Frequently, the agencies fail to make payments by several months or longer, with the following results: the project is delayed because the contractor does not have funds to meet payrolls and expenses; contractors add a large percentage to their bids to cover the unforeseen contingencies; some reliable contractors refuse to bid because of the agency's poor credit rating; and increased costs due to spiraling inflation; thus decreasing competition and increasing costs.

Little or no shortage of common labor is evident in the developing countries. A critical shortage of capable foremen and of skilled and semi-skilled labor, however, does exist.

SUMMARY AND CONCLUSIONS

With the exception of turnkey projects, the bidding and construction procedures are similar to those used in the United States. In general, the same holds true for the award of construction contracts. Shortage of materials and equipment, however, is a problem. The availability of contractors varies widely from country to country. There is no shortage of common labor. Trade school training would greatly alleviate the shortage of skilled and semi-skilled labor.

(1) The use of turnkey and multicontract procedures should be discontinued;

(2) The water supply agencies should protect their credit ratings by promptly meeting contract pay schedules, thus avoiding project delays;

(3) Project designs should be compatible with the availability of materials and equipment required for the successful completion of the project; and

(4) Inspection procedures and capable inspectors are needed to control the quality of workmanship and materials used in major works and facilities.

Chapter X

OPERATION AND MAINTENANCE

Water works management, as reflected in poor operation and maintenance is a serious problem that many of the developing countries need help in solving. This is a major problem which still plagues the water works industry in the United States and other industrialized countries, especially as it effects the smaller communities. Engineers frequently claim that lack of funds is the real problem. More often than not, however, the real cause is the lack of interest and attention to well-known operation and maintenance practices. Engineers tend to resist accepting managerial positions in preference to the more glamorous jobs of plant design and construction. The mundane tasks of developing and supervising operation and maintenance practices, therefore, are frequently neglected by those best qualified. This is unfortunate, since the techniques for solving these problems are known and well established.

The major causes of poor operation and maintenance are usually related to management policies and practices. In the developing countries it is most serious at the municipal level. These local water plant managers do not have many of the resources that are available, at a moments notice, to his counterpart in the United States or other developed countries. For example, he cannot pick up the phone and get immediate advice on an unusual treatment problem or arrange for quick service on a special piece of equipment. Nor can he call a State health office and obtain reasonably quick advice on water quality problems. There are a host of other examples which could be added to the above.

Providing these types of services along with legal, financial, engineering, and other kinds of advice and assistance to local communities is one reason why many of the developing nations have or are in the process of establishing water supply agencies within the structure of the national government.

A number of these agencies have material yards, warehouses, and shops well stocked with pipe, valves, fittings, meters, pumps, and tools. Frequently, they have well staffed and equipped water service departments and meter repair shops. Organizations were also observed with modern office space, including specially designed rooms for training purposes and good inventory control records and procedures. The most common deficiencies were in the areas of communication and transportation which cause undue delays in implementing the services needed by the local community.

With a few exceptions, the observations noted above were found in the national water agencies and in the larger metropolitan com-

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munities. Hardly any of the developing countries have water agencies at the State level with adequate resources or capabilities to render quick and efficient service to the local communities in solving local operation and maintenance problems.

Very few of the intermediate and smaller communities were found with the resources to handle these problems without outside assistance.

Due to the widespread occurrence of maintenance problems, the following discussion should be useful to the international assistance agencies, the community water supply authorities in the developing countries, the consulting engineering firms and others as a means of improving operation and maintenance practices. The discussion is divided into four main headings including support facilities and functions, basic organization, plant operation and maintenance, and distribution system operation and maintenance.

SUPPORT FACILITIES AND FUNCTIONS

The central or State agency in the developing countries usually must provide a much broader scope of assistance to municipalities than is the case in the United States or other developed countries. The nature of this assistance should be based on the resources available to the municipalities for operating and maintaining their water systems. To provide this assistance the national or State agency should be organized and staffed to provide some or all of the following services:

(1) Operation and maintenance training programs,

(2) Advice and assistance with special problems related to operation and maintenance,

(3) Review and evaluation of plant operation records and reports,

(4) Development and dissemination of operation and maintenance equipment manuals, standards and practices,

(5) Surveillance of water quality programs,

(6) Promotion of improved personnel policies, and

(7) Assistance in the procurement of equipment and services.

It may be necessary to provide the municipalities with complete personnel services to manage, operate, and maintain the local system while assisting with developing the municipality's capability to provide this service from its own resources.

At the municipal level, the complexity of organization and facilities needed for operation and maintenance will depend upon whether the water utility serves one small town, one large city, a metropolitan complex of communities from a single system, or a number of separate cities of various sizes. It may include one or all of the following: physical facilities and equipment, procurement of materials and supplies, warehousing and delivery of materials and supplies, operation and maintenance crews, and office functions. In cases where these requirements are beyond the capacity of the municipality they must be provided by the State or national agency.

Also, in cases where the water utility does all or part of its own construction work, this may be integrated partially or completely with the operation and maintenance facilities, i.e., common warehousing, equipment pools, and maintenance shops.

Physical facilities may be an integral part of the water treatment plant or a distinct complex of buildings. Facilities may include repair shops for pumps, motors, meters, other treatment plant equipment, and motor vehicles; warehouses and storage yards for equipment, materials, and expendable supplies; laboratory facilities; classroom space for training activities; and office space for the shop or warehouse manager and for necessary maintenance and inventory records.

Procedures for procurement of materials and supplies should be kept as simple as possible. In many countries, contracts and orders for supplies require the approval of the ministry of finance. This is highly undesirable and results in innumerable delays. The water utility, whether autonomous or not, should be given contracting and procurement authority. If the water utility agency is large and complex, with responsibility for many water systems, at least part of the authority should be delegated to the regional or local level.

Minimum bin levels should be established for all expendable supplies, materials, and spare parts. If the operation is large enough to warrant it, inventories can be maintained on data processing cards, with automatic reordering at prescribed minimum levels.

Adequate measures must be taken at warehouses and storage yards to protect against theft and vandalism.

The water utility must have the means to deliver materials and supplies expeditiously to the place where they are needed. This requires adequate transportation and communications facilities.

Maintenance facilities especially for preventive maintenance are certainly one of the most important features, but are frequently inadequate. Maintenance of all components of the water supply, treatment, and distribution system should be on a scheduled basis. There should be facilities for water meter inspection, testing, and repair, for leak detection, and other routine, frequently performed repair jobs. In many developing countries, the more complex repair jobs, such as those involving chlorinators or large motors, may be done at one central facility or perhaps by a traveling maintenance team.

Office functions necessary to an operation and maintenance organization have been inferred in the above. Primarily these involve inventory, operational and maintenance records. This function overlaps somewhat with management and may be included with it. Management is discussed in the next chapter.

BASIC ORGANIZATION

In several of the developing countries the national agencies have responsibility for complete community water supply activities, including construction, operations, maintenance, and management. It is rather difficult therefore to separate the operation and maintenance organization from the overall organization discussed in Chapter III. When the individual community water system is considered as a separate unit however numerous organizational problems are encountered.

First and foremost is the provision within the organization for adequate supervision and training. It is important that the persons selected to head this section of the organization should be experienced in good operation procedures, have administrative and leadership ability, and obtain job satisfaction from working in this field. They should also have the ability to evaluate and train personnel in the field of operation and maintenance and be capable of judging the potential of the staff to assimilate new knowledge and techniques. Where the supervisor in charge of operations and maintenance may fit into the organizational structure will depend on the number and size of the plants under his supervision. In a single small system, he may be the manager, the plant operator, and the maintenance man. In a large metropolitan system, there probably would be separate sections for operation and maintenance with each broken into smaller supervisory units. The important point is that continuous operation and maintenance of the entire system is necessary to produce a salable product and deliver it to the consumer. *This is the most important obligation that management has, and it should never lose sight of this fact.*

It is also important that the international assistance agencies give serious thought to the above statement. These agencies will not promote a proper image overseas by putting all their efforts into the construction of a project, regardless of the type, and giving inadequate attention to the local agency's ability to operate the project after it is completed.

The national water agency, through the use of adequate training and institution-building programs, can develop local responsibility for operation and maintenance. In this case, the national water agency or State water agency, if the country has developed an effective organization at the State level, might consider acting as a supply and advisory agency to communities. The agency could establish supply stores and technical assistance centers. The stores could be offered as a service to the communities on a cost basis, and would be useful particularly for stocking items difficult to obtain or seldom procured such as pumps, motors, and chlorinators.

PLANT OPERATION AND MAINTENANCE

Major elements of water treatment plant and water pumping facility operation and maintenance include the following: supervision; operator training; sampling, testing, and record keeping; operational procedures; and preventive maintenance.

Qualified operating personnel are sorely needed in all developing countries. With the exception of one country the water treatment plants in the countries evaluated were not generally being operated and maintained properly. In this one country, where considerable progress is being made, it is because of unusually well qualified and conscientious water authorities with good supervision of operation and maintenance personnel.

There is no shortage of intelligent men who are capable of acquiring the needed skills. Management must recognize the need for good operation and proceed to achieve this by developing supervisory personnel and by providing the job satisfaction and salaries necessary to retain them. In countries with a strong national water utility or authority this means the development of regional and local operating supervisors as well as central office personnel. In countries with mostly locally controlled water systems it means the development of operating supervisors in the individual utilities. They would receive general supervision from a national or provincial regulatory advisory agency, such as the department of public health, staffed with personnel well versed in operating practices. In a few developing countries, this phase already is approaching achievement.

Building on this base, a vigorous program of operator training must be pushed forward. This program may be handled in a number of ways, as suggested in the following: formal training programs at technical training centers or schools, semi-formal short courses conducted by the water utility agencies or perhaps by a university, and on-the-job training--perhaps even some type of apprentice program, although it might not be called by that name. In any case, training programs must be carefully geared to the characteristics of the people being trained. The trainees in many cases will have to be instilled with some very basic qualities, such as curiosity, desire to learn, motivation for self-improvement, and a sense of responsibility and pride in their work. All other elements of water plant operations and maintenance are dependent upon operator training programs.

One of these elements is water sampling, testing, and record keeping. Under present conditions in most developing countries, water sampling and analysis have been of little value. It must not be assumed, however, that an ambitious program to increase the number of samples taken and tests run would necessarily be of any great benefit. What is needed is sampling with a purpose which requires a simple functional laboratory and an understanding by the operator of the purpose of the tests.

The maintenance of operation records is vital, but it should be emphasized that unless the records are evaluated and put to use they have little meaning. Water production and consumption records are necessary prerequisites to determining unaccounted for water and future design criteria. Records of chemical usage can be helpful in the review of plant operation and for the scheduling of chemical purchases. From past records, seasonal variations in raw water quantity and quality and in operational problems can be predicted.

Water treatment plant operational procedures in most of these countries are greatly in need of improvement. There is strong indication in most cases that the operators are not taking full advantage of the treatment capabilities of water plants. In many cases, coagulation chemicals are used sparingly, if at all, even when dosing facilities are available. Dosages are seldom related to laboratory coagulation tests. Because of inadequately trained personnel, treatment units are frequently inoperable, with plants overflowing or functioning only as flow-through devices.

Chlorination is sometimes inadequate or used only intermittently. It appears, however, that the developing countries have progressed further in this aspect of water treatment than in most other aspects. Some of them, at least in the largest cities, are keeping good records of chlorine dosages and residuals and are making a real effort to maintain a chlorine residual in the distribution systems, which is very important from the standpoint of public health. The continuity of disinfection cannot be assumed from current records alone since it is subject to disruption because of failures in supply. Even where continuous chlorination is practiced, it is effective as a public health measure only under conditions of continuous pressure in the distribution system. The practice of intermittent pumping coupled with inadequate capacity in the distribution system and inadequate storage is so common as to constitute a most serious problem in the water supply utilities of developing countries.

In many countries, the maintenance of pumping facilities, treatment plants, and buildings is poor; in some countries, it is absolutely appalling. A significant factor is that the concept of preventive maintenance is utterly lacking in many developing countries. Equipment is given little or no attention until it fails. The subsequent efforts at repair can be both expensive and time consuming. It should be pointed out that this attitude applies to many other fields besides water supply. Therefore, developing a sense of the importance of preventive maintenance will probably require considerable effort since it involves changing a basic attitude or way of thinking. Here, again, the lack of proper supervision is a primary cause for poor preventive maintenance. Several observations were made of individual agencies and communities where good operation and maintenance practices were being carried out.

DISTRIBUTION SYSTEM OPERATION AND MAINTENANCE

Major elements of a good operation and maintenance program for water distribution systems should include the following:

(1) Continuous positive pressure throughout the distribution system,

(2) Preventive maintenance,

(3) Adequate elevated storage properly located on the distribution system,

(4) Leak detection and repairs, and

(5) Prevention and elimination of cross-connections, with the aid of plumbing codes and trained plumbers and inspectors.

One of the major existing deficiencies in the operation of distribution systems, the lack of adequate continuous pressure, is due in part to the shortcomings of design and to operation and maintenance practices. Examples of this are inadequate storage capacity in the distribution system and failure to consider the effects of extending the water system in the original design.

Many difficulties also stem from management policies such as lack of metering in appropriate situations, free water service to many customers, and inadequate budget for operation and maintenance.

As stated previously, the concept of preventive maintenance simply has not yet evolved in many developing countries. Nowhere is it given the emphasis that it needs. International lending agencies should, and in some cases are beginning to take the lead in educating the water utilities to this need. In addition to construction of new water facilities, serious consideration should be given to training projects whose sole purpose is to upgrade operation and maintenance practices.

One of the major effects of poor operation and maintenance practices in the developing countries is that unaccounted for water in urban water systems is frequently high; it will range considerably higher than in a well-run water system in the United States. The problem has several facets. In the first place, figures on the amount of water delivered to distribution systems are often unreliable or completely lacking. Master meters are not generally used and estimates are often based on rated capacities of pumping units. Reasons for water losses are myriad and include excessive leakage in the distribution mains, careless waste of water, leakage or nonregistration of water due to poor quality or inoperative house meters, unmetered or unauthorized house connections, delivery of "free" water for public agencies, and inadequate or unregulated plumbing practices.

The end result of these excessive water losses—together with minimal water rates that encourage waste, inadequately sized distribution systems, inadequate storage capacities, and (perhaps in fewer cases than might be thought at first) treatment plants of insufficient capacity—is that very few of these cities have potable water on tap at adequate pressure everywhere in the system 24 hours a day every day of the year. In some cases this problem is compounded by the deliberate practice of discontinuing the supply to the system or portions thereof during certain hours of each day.

SUMMARY AND CONCLUSIONS

Operation and maintenance is a common problem, particularly among the smaller communities in all countries throughout the world. The quality of service and the life of the water utility are directly related to operation and maintenance practice. For economic as well as public health reasons this problem is extremely important in the developing countries. Its solution is intricately related to finance, management and training. Both management and supervisory personnel must be adequately trained to understand the importance of good operation and maintenance procedures. Likewise operation and maintenance personnel must be trained to understand the importance of their responsibilities and the reasons for maintaining operating records and maintenance schedules.

(1) The official national or State water supply agencies, or both, should develop "manuals of practice" for operation and maintenance personnel;

(2) Water utility management should provide its personnel with detailed operation and maintenance schedules;

(3) Adequate funds should be provided in the water utility budget to employ and retain competent managerial, supervisory, operational, and maintenance personnel;

(4) Well planned and organized training programs for operation and maintenance personnel should be conducted at regular intervals.

Chapter XI

WATER UTILITY MANAGEMENT

The probability of success of a water utility depends primarily on the quality of the management.

To be successful, a water utility should provide an ample supply of potable water to the people in its jurisdiction while at the same time maintaining fiscal soundness.

Unless these objectives are satisfied, it will be difficult to qualify for capital grants and loans. Central governments should develop a national policy that will support the objectives mentioned above. Some of the fundamentals of good water utility management are discussed in this chapter.

MANAGEMENT QUALITY

The organization headed by an energetic and capable leader seems to make faster progress and to have a better chance of success. The evaluation teams met several men of this type: interested in their work, dedicated, capable, and enthusiastic. Nearly always this spirit seems to permeate the organizations they are directing. This increases immeasurably the prospects for successful operation.

The manager must be capable, qualified, and experienced. The remuneration and conditions of employment must be sufficient to attract and hold such a man. Generally, he will be an engineer, but he will need a good working knowledge of financial matters. Administrative ability is an essential requirement.

ORGANIZATION

Management of municipal water supply systems is sometimes lodged in a national agency with complete responsibility for planning, financing, designing, constructing, operating, and maintaining facilities. In some countries, these functions are the responsibility of local government, and in still others there is divided responsibility.

The type of organization is important. Since this subject is discussed in Chapter III it will not be elaborated on here. But the responsibilities, duties, and authority of the water utility, its governing board and manager, and their relations to each other must be clearly defined. The water utility can probably operate more successfully if it is at least semi-autonomous. Regardless of its organization level within the governmental structure there should be no doubt about its ability to levy and collect the revenues necessary for its successful operation.

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FISCAL POLICIES

Methods of financing water supply works were found to range from complete subsidy to fully self-supporting systems. Of course, even under a complete subsidy, funds required are raised from some taxing source. In many areas the attitude prevails that water should be furnished free. This attitude was well answered by one local official who said: "Sure it's free. There's the river. Just go and get your water. But if you want it brought to or near your home, you have to pay for it." This statement gains significance when consideration is given to the primitive peddlers carrying unsafe water in goat skins to homes having no piped water close by. The prices charged are extremely high compared with average rates for piped water.

Water utilities should be as nearly self-supporting as the local economy can justify. As far as possible, consumers should bear their share of the cost of the water supply, preferably by direct charge. Such a policy helps to decrease the amount of water wasted. This policy has been found to be helpful when construction loans are sought.

The Pan American Health Organization points out that in countries having an extremely low gross national product it may be necessary for the government to subsidize a portion of the cost, basing the water rates on a percentage of the local area's minimum wage scale, for example, less than 5 percent of a family's income. Within this context, it is recommended that the provision of water on a welfare basis should be at the government's expense, not at the expense of other consumers.

How much revenue is needed for successful operation? At least three basic cost elements must be considered:

(1) Current operation and maintenance costs—this is the cash outlay needed merely to meet day-to-day expenses, such as salaries, power, supplies, and repairs.

(2) Capital cost—if part or all of project construction funds are secured as a loan, principal and interest payments on the loan must be met. Even if these funds are in the form of a grant, the value of the use of that money should be included in the fiscal records since it does represent a part of the true cost of water service.

(3) Reserve funds—these should be set aside to meet future demands for replacement and extensions.

WATER RATES

The most difficult and desirable method of obtaining the income required for maintaining an adequate water utility is some arrangement for collecting revenue from the water customers themselves. The types of water rates are discussed in this section.

Water rates can be classified into five categories as follows:

(1) Flat (uniform) price—the most usual method when service connections are unmetered. All water users pay the same amount no matter how much or how little water they use.

(2) Unmetered, variable price—the alternative to the flat rate when service connections are unmetered. A variable water use charge is applied, based on considerations other than actual flow measurement, such as property values, area of property, front footage, area of house or buildings on property, number of fixtures, and size of service connection.

(3) Metered, with decreasing unit price as volume increases—this is the type of rate structure widely used in the United States, following conventional pricing policy.

(4) Metered, with constant unit price—the simplest plan.

(5) Metered, with increasing unit price as volume increases—this is the type widely used in Latin America; the rationale of this "social" rate structure is one of satisfying the basic water needs of low income groups at a very low (normally below cost) price, while also providing some motivation to limit water use. By this method the large consumer is, in fact, subsidizing the small consumer. This method can in some cases increase the total revenue to the water utility.

Nearly all rate schedules for metered water service include a minimum charge that, to a degree, covers the cost of the utility's readiness to serve. Normally, this minimum charge permits the use of a stated minimum quantity of water per billing period, beyond which quantity the next rate step takes effect.

Whatever category of water rates is used, the revenues derived should be under the control of management and not placed in general fund accounts. Furthermore, the water utility should be reimbursed for all services rendered, whether to individual customers, or for public services.

OTHER SOURCES OF REVENUE

Other sources of revenue successfully tapped for the support of water supply operation and maintenance include frontage assessment or special property improvement taxes, business operating license fees, plumbing fees, connection charges, and customer deposits when service is initiated to insure participation when service becomes available.

In the developing countries, numerous other methods have been used to collect revenue, especially in areas where the services are available only through street or yard hydrants or at public bath houses. These collection methods usually depend on some individual living in the area, who collects small fees from the local residents and retains a percentage of these funds for the services rendered, the remainder being turned over to the water agency. A much simpler way of handling this type of service would be for the municipal government to collect a small head tax from the residents in these areas along with their regular tax assessment and transfer these funds to the account of the water management agency. This type of "head tax" is used in some countries in Africa.

Frequently, the municipal government prevails on the water utility to provide free water for such public services as fire protection, public hydrants, and public institutions. This is not good practice and can be the difference between a financially self-sufficient public utility and one that is not.

USE OF METERS

The use of water meters is far from universal, and some countries have a policy against their use for the small consumer. Certainly the frequent experience of finding a substantial proportion of installed meters not working, together with a meter repair shop incapable of handling more than a small fraction of the indicated meter maintenance load, weighs against the principle of complete metering.

From a practical standpoint, a case can be made for a uniform or flat rate for those using small quantities of water, and metering all other users. Such a practice saves the cost of meters, their installation and repair, and regular meter reading. Small users have, in some cases, found that if they draw water slowly enough the meters do not register. Where 24-hour water service is not provided, the meters may register only the escape of air from the service lines as pressure is being restored.

One problem is that of poor quality and workmanship of water meters, fostered partly by a policy of purchasing meters on the basis of low bid only rather than on performance and durability. In this connection, a serious error is made by some water systems in permitting the customer to purchase the meter, often on the basis of price alone, and then to continue to own it. The customer is understandably reluctant to report its failure or to request maintenance as long as water continues to pass through it.

Nevertheless, careful consideration must be given to metering, even in the face of the difficulties described. No other means even approaches the same degree of management control in terms of accounting for water uses, which may eventually be reflected in very large capital savings for supply, treatment, and distribution facilities not actually needed if waste and careless losses are kept under reasonable control. For further details, refer to Appendix VI (The Municipal Water System of Governador Valadares, Minas Gerais, Brazil—A Success Story).

UNACCOUNTED-FOR-WATER

A major factor contributing to deficits in income is that unaccounted-for water in the countries studied amounts to 40 percent and sometimes as much as 50 percent of the total produced. This includes water furnished free to public standpipes, ornamental fountains, parks and recreation areas, government institutions, schools, and hospitals. In addition, there are always leakages in the distribution systems. Often in systems where management is poor, many illegal connections exist. During a detailed checkup recently made by a large city of an eastern country, 20 percent of the connections were found to be illegal, and were not previously known to exist; there was, of course, no payment for the water taken. A well-planned and implemented program of plumbing inspection, preferably under the supervision of the water authority, will reduce unaccounted-for water losses.

Unaccounted-for water is a most important management matter. Most of the consultant teams engaged in these studies recommended that before money was spent to provide increased water production, appropriate action be taken to reduce the amount of unaccounted-for water. This factor cannot be reduced to zero; in the United States it may average about 15 percent, though some cities have reduced it to 10 percent.

Action to achieve increased efficiency and reduction of unaccounted-for water frequently requires approval and backing of the Board of Directors or City Council, but it is apparent that such action will not take place unless action is originated by the general manager.

BILLING AND COLLECTION PROCEDURES

Billing, generally, is made monthly or bimonthly. In some cases, collectors are used to read meters as well as to collect bills. In other cases, bills are paid at central offices; in still others, they may be paid at local offices or local banks.

From the standpoint of good management, the water authority should be empowered to cut off the water services for nonpayment of bills. Without such authority management cannot maintain a viable system. Having this authority, and making use of it will keep delinquent accounts to a minimum and thus reduce the bookkeeping workload.

Another good management tool is to arrange for the water consumer to pay his bills at a local bank or other reliable business establishment. Where bills are collected at the individual homes, it is desirable for the collector to be readily identified as an employee of the water authority. Special uniforms or identification cards for the bill collector are some of the methods used by good managers in this regard. The above practices will conserve the customer's time and eliminate unofficial people from entering his home. These are good management practices to improve customer-management relations. The importance of regular and prompt billing should be emphasized. The practice of distributing the cost of the original service connection over a reasonable period of time is feasible where good billing and collecting methods are followed. This procedure will make it possible for many more people to have water and thereby increase the water revenue.

ACCOUNTING AND AUDITING

While very little detailed information was obtained on the system of accounts used and on auditing practices, the following are a few observations made by the consultant teams:

(1) In a few countries, good accounting and auditing procedures were found. One of the better central water supply agencies bills and collects for water use, keeps all fiscal accounts and records, and disburses all monies for operation and maintenance as well as for construction. It reads meters and bills by IBM monthly. Good and detailed accounting records are maintained, and the entire operation is audited by the National Court of Accounts.

(2) A major city in Latin America follows good accounting practices for all capital improvement projects, but it is only now working up cost figures for operation and maintenance.

Annual external auditing should be a policy carried out at all levels of government. Internal audits are a proper management tool, but there is no substitute for periodic external audits to safeguard public monies.

Top management should realize that good accounting and audit procedures are important in evaluating the overall operation of the water system. For example, a periodic review of the accounts will help to determine areas of inefficient operation. Likewise, efficient accounting procedures are essential for billing and collecting, for checking inventories, and for preparing reports on expenditures and operating costs. Internal audits are needed to prevent financial leaks and to protect management.

SUMMARY AND CONCLUSIONS

Poor management of water utilities is a serious problem in many of the developing countries. The causes are many and varied, including the following: a general lack of knowledge or experience or both, in the management field; poor organizational structure of the management institution; inadequate fiscal policies; an excess of political interference accompanied by a lack of political support; and the absence of adequate legal authority.

(1) AID and other international assistance agencies should adopt the policy, recently put into practice by IDB, of including in its loan agreements the provision that the borrowing country provide suitable management training for water agency personnel.

(2) The developing countries should give priority to sponsoring training courses for municipal officials and water utility managers in the field of administrative management. They should attack this problem at all levels, including academic training, seminars, refresher courses, and correspondence courses.

Chapter XII

DEVELOPING PUBLIC SUPPORT FOR COMMUNITY WATER SUPPLY PROGRAMS

The evaluation of community water supply programs in the 12 countries studied revealed that lack of effective community support often seriously weakened these programs. As planners and program implementors focused their efforts on drawing up technically sound water systems, they tended not to give sufficient attention to developing understanding and support for the projects among key government officials, community leaders, influential individuals, and the public at large. Often international advisors quite naturally assumed that the host country personnel would be more competent than they in handling this facet of the program design. In fact, the host country engineers were somewhat limited in assessing and solving these human and organizational problems. This was a reflection on the technical orientation of their training and to traditional perceptions of their professional role and status.

It is clear that international water supply development advisors must concern themselves not only with the technical problems but also with the educational requirements for behavioral change. Otherwise, these human factors may interfere with smooth implementation of their project or limit its contribution to the general welfare. They must be able to help host country engineers and planners to develop and carry out educational programs designed to assure public understanding and support for improved water supply systems.

A discussion of some of the issues and realities that must be taken into account in developing the educational component of water supply development programs follows:

Identification of cultural, social, and psychological aspects of developing countries that appear to have a direct bearing on community water supply development;

A description of educational goals for community water supply development, and some suggested approaches for attaining these goals;

Recommendations for approaches through which international water supply development advisors may assist the host country in planning for and implementing educational components of the program.

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CULTURAL VALUES AND CUSTOM

As only 10 percent of the people in the developing countries now have adequate safe piped water supplies, the extensive introduction of modern water systems into these countries will revolutionize life and alter the daily activities of many people in very tangible ways. In water shortage areas, where women and children spend a substantial portion of their daytime hours transporting water over long distances, the installation of a piped water system meets one of their most critical needs. As many routines of daily living are a source of psychological and social satisfaction, they are not easily changed and reactions to this technical advance in water supply development will vary widely. For example, when a modern water supply system is installed, the village woman long accustomed to fetching the family water supply is deprived of the social contacts this daily chore affords. The convenience, provided by a modern supply system, of doing the laundry at home may not fully compensate for the visit among friends at the village pond or well.

Sometimes cultural beliefs and values are so deeply imbedded in local customs that the people will refuse to give them up. To cite other examples: in one country water from a sanitary well was rejected because, according to local belief, a water source must be open to the sun to be fit to drink; a U. S. Indian tribe would not accept a modern water system because delivery of water in a round pipe is contrary to its religious beliefs.

In contrast, some communities welcome new water systems because they facilitate the practice of cultural and religious beliefs. In countries such as India, where cleanliness is a very important element in the culture, several baths and changes of clothing a day are considered a necessity. A new water system which assures adequate quantities of water for these purposes is therefore welcomed.

As every country has its unique culture, each one has its unique way of responding to modernization efforts. Certain cultural factors have been found to be particularly pertinent in predicting responses important in planning for community water supply development. They include concepts of maintenance, folk medicine, social class structure, and the value placed on saving "face."

Where concepts of maintenance are not well developed the following human responses may not occur: appreciation of the need to service equipment regularly; recognition of the need to budget adequately for managerial and technical personnel; realization of the need to stock extra parts; acceptance by the consumer of the idea of regularly paying for service and contributing to it. Where folk medicine is practiced the community may not appreciate health benefits of a new system and may not follow procedures necessary to prevent contamination of the supply. Social class difference, in addition to causing inter-communication problems familiar in our own culture, also may deter the host country technical personnel in performing certain of their professional tasks. For example, these might include those requiring association with members of different classes; performing manual labor; or soiling their hands.

Where maintaining feelings of personal dignity, expressed in some cultures as "saving face" is highly desirable, the foreign advisor must be particularly sensitive to the importance of this value in developing and carrying out effective working relationships, training programs, and problem-solving approaches.

Cultures of developing countries are rarely static. In most of these countries, changes in ways of living are accelerated by large numbers of migrants from rural areas when they move to the cities to seek improvement of their lives and to gain some of the advantages of modern technology. Even in rural areas, important changes are resulting from recognition of needs and a belief that conditions can be improved. However, this is a slower change process.

There is a very natural tendency on the part of both the host country planners and the foreign advisors to give an inordinate amount of attention to the exotic, unusual, or dramatic aspects of cultural response to water supply development programs. Actually, in most of the developing countries, gaining public support for community water supply development is not so much a problem of surmounting traditional cultural barriers as one of developing public and official understanding of the need and nature of such improvements, the resources required to bring them about, and the responsibilities they entail for the government and the consumer.

EDUCATIONAL GOALS AND APPROACHES

The educational goals that must be achieved to assure public support for community water supply development are outlined as follows:

(1) *To obtain public understanding of the relationship between safe potable water and community health.*

Public officials, community leaders, employers, and other influential persons must understand that community water supplies, adequate in quantity and quality, are essential for the protection of the health of the community; that impure water supplies can result in serious epidemics, widespread disease of children, and a general low level of health. The public needs to understand this water-disease relationship: the importance of securing a safe water supply; how to store and use water hygienically; how personal hygiene and household cleanliness protects family health.

(2) *To obtain public understanding of the technical and resource requirements for development of community water supplies.*

Persons responsible for planning and administering the system must know how to assure the public that technically sound procedures are followed and that unnecessary luxuries are eliminated when they are not within the means of the community. This requires a careful analysis of each community's needs and resources in planning for this development, an understanding of the limits of their legal authority, and how to develop effective administrative mechanisms for community water supply development. The consumer—public also must appreciate these factors to avoid discontent regarding payment for and delivery of services.

(3) *To obtain public acceptance of responsibility for development and maintenance of community water systems.*

Public officials, community leaders, and others must accept responsibility for planning, obtaining budget, and directing installation of community water systems. They must also inform the public of the need for these systems and obtain their support and participation in this development. Water supply engineers and other personnel must carry out the public relations activities necessary to assure understanding, participation, and support of community leaders and consumers in water supply development and maintenance activities. The public will need to accept sustained responsibility to pay fees for services, carry out certain procedures to assure safety of the supply, provide for installation of approved equipment in their homes, contribute to financing, and participate in planning certain aspects of the system.

Successful implementation of these educational goals requires skillful planning, development, and application of appropriate educational methods, and a sharing of educational responsibilities among the many individuals concerned: water engineers, government officials, educators, community workers, and community leaders. Plans for educational programs need to be drawn up simultaneously and in rapport with the development of the water systems plans. At the same time that engineering surveys map out the technical information needed to build the system, educational surveys should be conducted to define community leadership patterns, consumer attitudes and practices related to water as well as educational resources pertinent to development of the educational program.

Selection of educational methods and development of teaching aids must be based on a careful analysis of the educational problems and the resources available to meet them. When attitudes are to be changed, new practices adopted, cooperative community action undertaken, or new responsibilities assumed, group and community organization methods are usually most suitable. In countries where literacy rates are low and channels of mass communications are minimal or non-existent one must be alert to the limitations of these means for informing the public. There are usually better "grapevines" or word-of-mouth channels of communication to the public that can be tapped. The written word has little impact; the spoken word cannot do the job alone.

Many opportunities for education occur in the normal course of community water supply development activities. Others have to be arranged. Meetings held early in the developmental phase offer international water supply advisors an excellent opportunity to educate officials and community leaders. These meetings can usually be planned to encourage the analyses of the problems involved, the exchange of opinions or solutions, the clarification of technical, legal, and financial requirements and the development of group consensus on practical plans of action. This kind of involvement helps to build personal commitment to continuous support which is needed to maintain effective community water systems. In addition to the meetings of water boards and councils, open meetings for the community where local leaders and officials interpret the program and benefits to be derived and obtain wider participation in the discussion of problems and action to be taken are very useful in building public support. The education which occurs in these meetings should be supplemented in individual and social group contacts by community water systems staff and community workers of other agencies.

The use of appropriate teaching aids, particularly flipcharts, blackboards, flannelgraphs, posters, booklets, and fliers, will increase the effectiveness of all these educational activities. Ideas, concepts, and information can be more effectively and accurately communicated by employing these media. To be effective the teaching aids must be carefully designed for the specific teaching tasks, the situations in which they will be used, and for the audience to be reached. Visual aids consisting mainly of line drawings and photographs have been very effectively employed in teaching illiterate and semi-literate groups. They can be very inexpensively produced. Community water supply developers should seek professional advisors skilled in designing these materials for the particular audience to be reached and in training workers in the use of those aids.

The government unit responsible for community water supply development rarely has sufficient human resources to undertake this educational endeavor alone. Ministries that do have health education and community education experts and field staff capable of assisting, need to be approached for help. The Ministries of Health, Education, Social Welfare, Agriculture, and Information, are among those which may have competent staff in this field. In-service training opportunities must be provided to prepare these workers for their educational tasks.

The evaluation teams found that the most difficult problems are in the urban areas, particularly those fringe communities where the recent migrants from the rural areas reside and where readjustment to urban society is in progress. This population is very difficult to reach. They do not belong to organizations, the majority are illiterate, they have few resources. Many are not even familiar with the monetary economy and town living, and they are often itinerant. These types of communities will require intensive educational efforts by competent field workers prepared to contact individuals and small family groups, in order to locate and develop means of reaching and educating these people. Through face-to-face contacts, confidence and understanding can be developed. Since these people generally have other urgent problems in addition to community water supply, it may be necessary to provide guidance on their other problems as well, in order to obtain better support for the community water supply program.

The evaluation teams found that breakdowns in public support for community water systems frequently occur following the installation of the system. To prevent this, sustained programs of education and public relations need to be planned for and inaugurated early. Application of the following basic principles of good management and public relations is essential to assure the continuing support and cooperation of the consumer in safeguarding the water supply and financing the maintenance and expansion costs:

(1) Provide good service.

(2) Keep the public informed on present and future activities of the water utility in order to maintain their interest and support.

(3) Assure that water bills are accurately and properly rendered, that the bill paying procedure is understood, and is as convenient as possible for the customer.

(4) Adopt a good system for receiving and following up complaints.

(5) Treat the public and customer with courtesy.

(6) Maintain neat and orderly appearance of the facilities and staff.

SUMMARY AND CONCLUSIONS

Certain measures should be taken by international water supply personnel to assure that host country governments obtain the public support so vital to the success of community water supply projects. To be effective, these measures must be woven into the process of project development from the very beginning. They *cannot* be postponed until final plans and negotiations are solidified. Rather they should be a part of the discussions and negotiations with the host country officials, in the feasibility studies, in the project agreements, in implementation activities, in progress reports, etc. They include the following:

(1) Assessment of the extent to which the host country government: appreciates the need for obtaining public support; develops realistic and sound plans for accomplishing this; has available or can develop the educational and motivational resources needed; is committed to carry out this aspect of the program.

(2) Provision of assistance in planning educational activities to obtain public support by conducting surveys to assess cultural resistance to change and educational problems and to locate educational resources.

(3) Provision of technical or material help in the development of educational resources where adequate ones do not exist.

In order to carry out these measures, professional advice in the field of health education may be required.

APPENDIXES

Appendix I

CONSULTANTS AND PROJECT STAFF

Consultant Teams

Names of Consultants	*Country Evaluated*	*Dates*
Severiano A. Garza * Ely J. Weathersbee Stanley E. Kappe Joseph M. Dennis †	Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, Panama	May 5-June 3, 1967
Herman G. Baity * Jean L. Vincenz Martin F. Flentje	Korea	July 1-July 31, 1967
David H. Howells * Wade G. Brown Antonio Santiago-Vazquez	Peru	July 29-August 27, 1967
Earnest Boyce * Ralph C. Pickard Jerome B. Gilbert	Philippines	August 12-September 3, 1967
Jean L. Vincenz * Raymond J. Faust Gerard A. Rohlich	Pakistan	November 12-December 10, 1967
Herman G. Baity * Harris F. Seidel Paul E. Morgan	Thailand	November 12-December 10, 1967
Robert R. Harris * Leonard M. Board † G. LaMar Hubbs ‡	Brazil	March 3-March 29, 1968

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*Team Leader

†PHS Officer

‡PHS Officer assigned to Project by Water Supply & Sea Resources Program (9/23/67-8/15/68)

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Project Staff

Robert R. Harris, Project Director
Donald A. Anderson, Staff Engineer
Billie D. Saunders, Secretary (2/1/67-5/20/68)
Theresa C. Pope, Secretary (5/20/68-8/15/68)

Appendix II

BRIEFING AGENCIES

Agency	*Principal Officials*
AID, Department of State	Mr. Arthur H. Holloway Mrs. Frances V. Johnson Mr. Harold Conger
Inter-American Development Bank	Mr. Joseph Freedman Prof. Roberto Olivero Mr. Rafael Uride-Uride
International Bank for Reconstruction and Development	Mr. Harold Shipman Mr. Reginald Bowering
Department of Commerce	Mr. Konstantine L. Kollar Miss Evelyn Hessler
Pan American Health Organization	Mr. Charles S. Pineo
U. S. Public Health Service	Mr. Leonard M. Board

Appendix III

EXAMPLE OF TRAINING COURSE OUTLINE

Engineering Aide—Brazil

Classes held four hours each week (one morning) for a total of 11 weeks.

I. INTRODUCTORY REMARKS
  - A. Training program of the water department
  - B. Importance
  - C. How it will benefit the trainee

II. HISTORY
  - A. Rio de Janeiro water system
    - 1. Date organized
    - 2. Growth and development
  - B. SURSAN
    - 1. How it was developed, why, and when
    - 2. Extent of present system
    - 3. Organizational structure of SURSAN
    - 4. Organizational structure of water department
    - 5. Plans for future growth and development
    - 6. SURSAN rules and regulations
      - (a) civil service rights
      - (b) pay scales
      - (c) health benefits
      - (d) retirement plan
      - (e) vacation and holidays

III. SANITARY SIGNIFICANCE OF A SAFE WATER SUPPLY
  - A. Health, social, and economic value of water
  - B. Accomplishments of a safe water supply
  - C. The engineering aide's role in insuring safe water

IV. WATER WORKS OPERATION
  - A. Water works operation manual
    - 1. Uses of water
    - 2. Quality of water
    - 3. Disinfection
    - 4. Sanitary protection of well and surface supplies
    - 5. Water storage
    - 6. Water pumping
    - 7. Sanitary protection and operation of water distribution
  - B. Hydraulics

- C. Corrosion
- D. Map reading
- E. Safety practices
  - 1. Importance
    - (a) personal safety
    - (b) avoid personal loss
    - (c) to be outstanding
    - (d) to avoid making an unfavorable impression
    - (e) prevent injury to others
  - 2. Safe methods

V. PUBLIC HEALTH ASPECTS

- A. Water-borne diseases
  - 1. Typhoid
  - 2. Dysentery
  - 3. Cholera
  - 4. Hepatitis
- B. Water transports disease organisms
- C. Removal of disease organisms from water
  - 1. Filtration
  - 2. Disinfection
  - 3. Good distribution system
- D. Sanitary sewers
- E. Plumbing
  - 1. Importance
  - 2. Cross-connections

VI. WATER DISTRIBUTION SYSTEM MATERIAL

- A. Distribution system
  - 1. Cast iron pipe
    - (a) types of joints
    - (b) care of handling
    - (c) advantages and disadvantages
    - (d) method of cutting
    - (e) bedding
    - (f) weight
    - (g) diameters
  - 2. Steel pipe
    - same
  - 3. Cement asbestos
    - same
- B. Building services
  - 1. Lead
    - same

        2. Plastic
            same
        3. Galvanized iron
            same
        4. Copper
            same

VII. EQUIPMENT OPERATION AND MAINTENANCE
- A. Pumps
- B. Jack hammers
- C. Generators
- D. Air compressors
- E. Special equipment

VIII. PROPER CONSTRUCTION METHODS
- A. Cast iron pipe
    - 1. Joints
    - 2. Tapping
- B. Lead pipe and joints
- C. Plastic pipe
- D. Copper pipe
- E. Galvanized iron pipe
- F. Service connections
- G. Pipe laying
    - 1. Trench depth
    - 2. Trench width
    - 3. Bedding
    - 4. Filling and testing
    - 5. Disinfection
    - 6. Backfilling
- H. Valve repair and maintenance
- I. Installation of valve box
- J. Meter maintenance
- K. Location of hydrants
- L. Thrust blocks
- M. Care of tools

IX. PERSONNEL MANAGEMENT
- A. Office procedures
    - 1. Records
    - 2. Department rules
- B. Duties of personnel under you
    - 1. Service truck foreman

2. Crew chiefs
3. Laborers
4. Clerks

X. PUBLIC RELATIONS

A. Meaning
   1. Impression made upon the citizens
   2. A water department is no better than its customers think it is
   3. You are "Mr. Water Department"

B. Scope
   1. Daily contacts with the public
   2. Employee's attitude toward the customer's problems
   3. Supervisor's attitude toward the men under him

C. General procedures from customer public relations
   1. Don't give answers too quickly—give a sympathetic hearing to all complaints.
   2. Give equal treatment to all customers
   3. Maintain a good physical appearance—clothes, hands, shave, etc.
   4. Emphasize importance of cultivating one's own personality
   5. Courtesy is like oil—it keeps the employee's daily contact with each other and with the public running smoothly
   6. Practice good telephone manners

D. Handling of complaints
   1. Courteous receipt of the complaint
   2. Prompt assignment of someone to investigate and correct this situation
   3. Follow-up to see that the complaint, if warranted, had been corrected
   4. Notification to the customer of the correction

E. Handling employees under you
   1. Enthusiasm for one's own work and the department
   2. Know your personnel and their capabilities
   3. Assign work accordingly, displaying confidence that the employee will do the job with quality workmanship
   4. Be patient and understanding and courteous
   5. Always be willing to listen—much can be learned from an experienced man

Appendix IV

DESIGN STANDARDS

The design standards most frequently used by engineers in the developing countries are listed as follows:

Item	*Range of Values*	*Most Frequent Values*
Design Period	10-25 years or 100% growth whichever is greater	20 years or 100% growth whichever is greater
Domestic Consumption (liters per capita per day)		
Small systems	50-200	115-150
Larger urban systems	150-300	180-250
Public taps	5-40	10-15
Maximum Daily Use (times average)	1.2-1.5	1.2-1.5
Maximum Hourly Use (times average)	1.5-4.0	1.5-2.5
Distribution Storage (% daily consumption)		
Large systems	30-70	40-50
Small systems	100	100

Fire flow provided for only in large communities having fire departments:

Hours of Operation	12-24	12-24
Minimum Static Pressure in meters of water height	7-23	10
Maximum Static Pressure in meters of water height	46-50	50
Maximum Dynamic Pressure in meters of water height	100	—

Provision for Unaccounted-for Water (% total flow)	20-40	25-35
Rapid Sand Filtration Rate (gallons per minute per square foot)	2-3	2-2½
Slow Sand Filtration Rate (gallons per day per acre)	250,000 with iron removal	
Sedimentation Period	2 hours with iron removal 4 hours for surface water	

Appendix V

THE MUNICIPAL WATER OF GOVERNADOR VALADARES, MINAS GERAIS, BRAZIL

THE CITY

Governador Valadares was established as a municipality in 1938. It is located on the Rio Doce (river), and on the principal federal highway between Rio de Janeiro and Salvador, about 150 miles northeast of Belo Horizonte, the state capital of Minas Gerais. It is about 500 feet above sea level. The growth of this city has been phenomenal, as shown by the following census data:

Year	*Population*
1938	3,280
1940	5,734
1950	20,357
1960	70,494
1964	100,307 (estimated)
1966	134,368 (estimated)
1985	274,000 (projected)

The municipality has prospered as a center of trade and commerce, with the beef cattle industry supplanting lumbering as a major industry. One of the largest meat packing plants in Latin America is located in Governador Valadares. Mining and processing of nonferrous minerals, including semi-precious gems, account for 80 specialized industrial firms. There are now almost 300 industrial establishments in the municipality. In March of 1968, the new Minas Institute of Technology (MIT) admitted its first class of 90 students into its engineering course. This school was established with funds privately contributed, mostly through the Foundation "Percival Farqhuar," and receives no public funds. Courses have been started in metallurgy and mechanical engineering, with a faculty of 15, mostly full-time with some half-time. Later it is planned to add other engineering programs and a liberal arts program. It is intended to devote a major share of its resources to applied research related to development of the Rio Doce Valley, and already has contracted for nine special projects. All students are required to take English language training.

CHRONOLOGY OF THE GOVERNADOR VALADARES WATER SUPPLY

The public water works in Governador Valadares was one of the first treatment plants designed and constructed by SESP in 1944-46. The design population of 14,000 was exceeded by the time the plant was completed. The original operating agreement with the municipality provided for SESP to operate the plant, with municipal officials responsible for the collection of water charges, to be transferred to SESP as reimbursement for operating costs. The capital cost of construction had been a direct grant by SESP. This arrangement did not succeed. The municipality did not enforce payment of water bills, with the result that wastage was excessive and with the rapid growth of the city a shortage of water developed. Furthermore, the collections returned to SESP were inadequate to meet operating costs.

About 1952, SESP responded to the request of municipal authorities and established an autonomous water and sewer authority (SAAE) which in turn contracted with SESP for management, operation, and maintenance of the water supply and sewer system including the billing and collection of water and sewer charges. This pilot undertaking was the forerunner of more than 500 such municipal authorities in Brazil today. One of the early innovations in management was an arrangement with banks in the city for water bills to be paid at any bank. No commission is charged for this service, which has become the established practice throughout Brazil.

The subsequent success of this pioneering undertaking has probably exceeded all early expectations. The immediate achievement was enforcement of collections, accompanied by the installation of meters for all major consumers, thus reducing wastage and eliminating the critical shortage problem. This happy situation was short-lived, however, as the rapid growth of the city soon produced demands exceeding the design capacity of the system. Improvement and additions to the plant and distribution system have been made in several stages during the ensuing years, all financed from water revenues except for a small grant by DNOS in 1951. The installation of 1,000 meters on large consumer connections in 1959 contributed to an increase in minimum pressure from 15 psi to 60 psi, and permitted an increase in service connections of about 15 percent. Another expansion program started in 1959 was funded by a substantial increase in water rates, 40 percent of which was allocated for improvements.

It became necessary in 1964 to prepare for a major expansion of the treatment plant and distribution system. A feasibility study was made by FSESP engineers, and when the National Water Loan Fund was inaugurated in 1965, through an agreement between USAID Brazil and the Government of Brazil, an application was submitted and approved for a loan of NCr$600,000 (almost US$200,000). This loan, to be repaid from water revenues, is being applied to extend the distribution system. At the same time a total of NCr$800,000 (about US$250,000) is being spent from reserve funds, accruing from water revenues, on major plant expansions and the distribution system.

The financial soundness of this utility operation is shown by the following breakdown of operating costs and revenues for 1967:

Revenues	—	NCR$723,997.97	($223,000)
Personnel costs	—	143,184.00	(19.7 percent of revenue)
Materials costs	—	58,233.00	(8.04 percent of revenue)
Services, accounting, and maintenance	—	123,446.00	(17.06 percent of revenue)
Extension of distribution system	—	58,616.00	(8.09 percent of revenue)

Operating costs, including extensions of the water systems, thus amounts to less than 55 percent of total revenues.

The water system supplies 8,266 service connections (3,621 or 44 percent metered), which serve:

12,629 dwelling units, @ 4.6/d. u. = 63,000
1,489 commercial establishments
264 industrial establishments

It is estimated that 42 percent of the population is served by house connections, and the expansion now underway will increase this service to 70 percent. The metering of service connections is provided on a selective basis, with emphasis on industrial, commercial. and other large consumers. About 50 percent of the household meters are inoperative. Experience has shown that about 60 percent of the single family consumers do *not* exceed the minimum bill per month. Meters are installed on all new service connections. Meters of large consumers are examined and repaired periodically (usually required once a year), in a well-equipped shop at the water plant, with two full-time mechanics. All metered consumers pay a maintenance charge of U. S. 8¢/mo.

Water rates in Governador Valadares, as in other self-sustaining water systems in Brazil, are tied to the minimum monthly wage which is adjusted once or twice a year by the federal government, based upon a cost-of-living index. The minimum monthly bill in Governador Valadares is 2 percent of the minimum monthly wage of NCr$85.00, or about US$0.53 for up to 20M^3, or U. S. 10¢/1000 gal. Water rates are scaled higher as consumption increases. Fire protection is provided through fire hydrants, most of which are metered with consumption paid by the fire department. Construction connections are metered and consumption billed to the contractor. The municipality does not pay for water supplied to municipal buildings and parks (less than 2 percent of total produced). Water bills are computed and prepared under contract with an IBM equipped contractor in Belo Horizonte. Collections are essentially 100 percent, due to a rigid enforcement program providing that when accounts are not paid within 15 days the service is shut off (about 200 such cases each month), and restored only after payment in full, including charges for shutting off and turning on the service. New service connections are installed by the water department after payment in advance. Average cost is NCr$140 (U.S.$43.75) including cost of the meter (NCr$47.00).

The construction program now in progress and to be completed this year will more than triple the production capacity, to 10 m.g.d. The raw water source is the Rio Doce whose turbidity never falls below 100 and appears to carry a heavy load of suspended clay material. Plant design was based on 150 1/c/d for a population of 274,000 predicted for 1985. Conventional treatment is provided with fluoridation scheduled to be added in 1969. The plant is operated 24 hours daily. There is a fairly well-equipped laboratory and physical, chemical, and bacteriological samples are examined daily, although no samples are collected from the distribution system. Chlorine residual at plant effluent is maintained at 0.15 ppm. Water "loss" was reported for February 1968 as 16 percent of that produced, including filter wash water. Monthly operating and fiscal reports are submitted to the district office in Belo Horizonte and headquarters office in Rio de Janeiro. The office is well-equipped with accounting machines. The entire operation is conducted with a total staff of 44 full-time employees for the water and sewer systems. An active public relations policy is pursued. Informative exhibits are displayed in prominent locations, and telephone inquiries are handled courteously and promptly. A careful record is kept of complaints which are classified, tabulated, and analyzed monthly. There were only 8[illegible] complaints of all types received in February 1968.

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